

**THE DADIA–LEFKIMI–SOUFLI FOREST NATIONAL PARK, GREECE:
BIODIVERSITY, MANAGEMENT AND CONSERVATION**

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**WWF Greece
Athens 2010**

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Suggested citation:

Author's name. 2010. Title of paper. – In: Catsadorakis, G. and Källander, H. (eds). The Dadia–Lefkimi–Soufli Forest National Park, Greece: Biodiversity, Management and Conservation. WWF Greece, Athens, pp. 000–000.

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Published by:
WWF Greece,
26 Filellinon str.,
GR-105 58 Athens, Greece
Tel:+30 2103314893, fax: +302103247578
e-mail: support@wwf.gr
<http://www.wwf.gr>

ISBN 978-960-7506-10-8

Typeset by ZooBo Tech, Torna Hällestad, Sweden

Printed by Schema + Chroma, GR-574 00 Sindos, Thessaloniki, <http://www.kethea-print.gr>

Illustrations by Paschalis Dougalis

Maps on pages 18–28, 36, 42, 86, 89, 217 and 231–243 prepared by Nikolaos Kasimis, those on pages 23, 27 and 232 by Konstantinos Poirazidis.

The book was printed on 130 g FSC-certified Sappi Era Silk paper.

Cover photo: Giorgos Catsadorakis.

Vegetation and habitat types

Georgios Korakis and Achilles Gerasimidis

The landscape of the Dadia–Lefkimi–Soufli National Park is dominated by woodland that expanded significantly during the second half of the 20th century. It comprises a mosaic of typical southern Balkan sub-Mediterranean vegetation types, which have received little systematic study. In this paper we identify and classify the vegetation diversity in the Park in terms of habitat types based on a field survey. We assigned plant communities to nine habitat types which are described and mapped. These include, sclerophyllous scrub formations i.e. *Juniperus oxycedrus* arborescent matorral, two types of grassland i.e. sub-continental steppic grasslands and pseudo-steppe with grasses and annuals of the Thero-Brachypodietea, four forest habitats i.e. thermophilous oak woods of Eastern Mediterranean and Balkans, eastern Mediterranean high maquis, sub-Mediterranean pine forests with endemic Black Pines and Mediterranean pine forests with endemic Mesogean pines and two riparian types i.e. Greek alder galleries and *Salix alba*-*Populus alba* galleries.

Keywords: Sub-Mediterranean vegetation, habitat classification, thermophilous oak woods, Mediterranean pine forests, European Union Habitats

Introduction

Dense woodland occupies the landscape of the Dadia–Lefkimi–Soufli Forest National Park (hereafter called DNP). The hilly and largely forested region that lies between the eastern outskirts of the Rhodope mountain range and the Evros river valley has until presently suffered relatively low levels of human disturbance and ecosystems mismanagement (Adamakopoulos et al. 1995, Kati 2001).

The conservation status of National Park since the early 1980s, in combination with the depopulation of the settlements, additionally favoured forest expansion in the area of Dadia. During the second half of the 20th century (1945 – 2001) the forest cover increased from 46% to 72%, i.e. one of the highest in Greece. During the same period forest clearings decreased significantly from 35% to 9% (Triantakonstantis et al. 2006).

Today the landscape comprises a mosaic of typical southern Balkan sub-Mediterranean vegetation types that have received little systematic study. The description and classification of the vegetation and habitat types of

the DNP could provide managers and visitors essential information for understanding the composition and structure of its ecosystems and also be a valuable tool for a rational management of the area.

Physical parameters

Geological substrate

The landscape is hilly, mostly of gentle relief with generally smooth slopes and with an altitudinal range from 10 to 654 m asl. DNP belongs to the Circum-Rhodope tectonic belt situated very close to the old crystalline Rhodope zone (Mountrakis 1985, Jacobshagen 1986). Prevailing rock types in the area are gneiss, mafic and ultramafic magmatites, tertiary deposits and volcanic tuff. Granite and mixed flysch occur locally (Vardakis et al. 1996).

The soils are generally not eroded or only slightly eroded due to their cover of natural vegetation that has protected them (Vardakis et al. 1996). They vary from

deep to shallow depending on the relief and former land use. The spatial distribution of the main soil types following the classification of the European Soil Bureau Network is shown in Fig. 1; their description is provided in Table 1.

Climate

The climate is classified as Csb according to Köppen's classification, i.e. Mediterranean with short summer periods and mild winters. The Mediterranean character of the climate is significantly attenuated due to the prevailing northern winds in the area. This results in a regionally harsh climate with continental affinities.

On the basis of Emberger's (1955) pluviothermic coefficient, and the minimum temperature of the coldest month of the year, the area belongs to the sub-humid Mediterranean bioclimatic belt with harsh winters (Mavrommatis 1980). According to the xerothermic index of Bagnouls and Gaussen (1953), the area can be included in the mild meso-Mediterranean character of the Mediterranean bioclimate with a dry period ranging from 40 to 75 days.

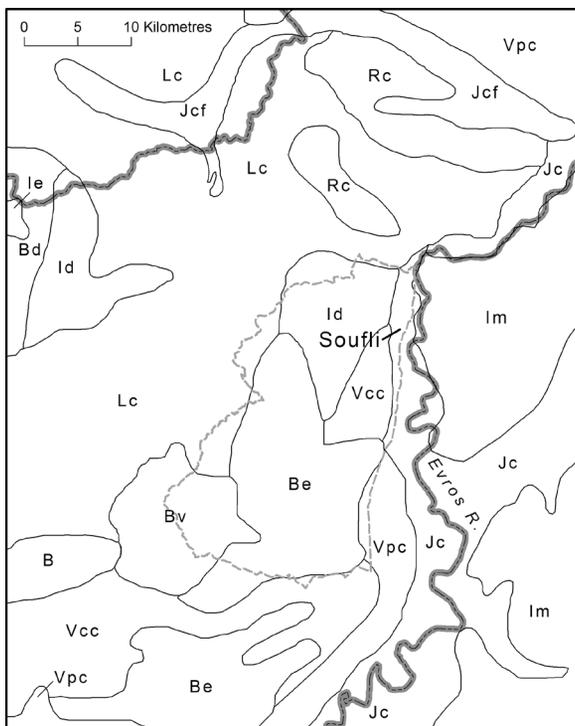


Fig. 1. Soil map of Dadia–Lefkimi–Soufli Forest National Park. Abbreviations are explained in Table 1 (modified after Jones et al. (2005)).

Vegetation

The physical setting mainly determines the character of the plant communities in DNP while low anthropogenic impacts only marginally modify the physiognomy of vegetation.

The area is covered to a large extent by sub-Mediterranean forests of high biological value, typical of the meso- and supra-Mediterranean vegetation belts¹ (*Quercetalia pubescentis*). Xerophytic coniferous and thermophilous deciduous oak forests are the predominant forest types in the area. In early phytosociological studies of the Balkan area the vegetation of such deciduous oak forests is characterized as 'sub-continental'. It occupies the inland lowlands, hilly and submontane altitudes where the influence of the Mediterranean climate declines and the continental characteristics become more pronounced (Oberdorfer 1948, Debazac and Mavrommatis 1971, Dafis 1973, Horvat et al. 1974, Athanasiadis 1986, Korakis 2003).

According to the classification of Bohn and Neuhäusl (2000/2003) given in the Map of the Natural Vegetation of Europe, the dominant vegetation types of the DNP are the North Aegean *Pinus brutia* forests and the Macedonian-Thracian Balkan oak forests (K22 and G28 respectively). Greek mixed Oriental Hornbeam-Downy Oak forests (G57) occur on the boundaries of the area towards the warm cline while Macedonian-Thracian beech forests (F154) occur on the boundaries of the area towards the cool cline. Characterization of the vegetation units according to Bohn and Neuhäusl (2000/2003) is provided in Table 2 and their distribution shown in Fig. 2.

Habitat classification

In order to identify and describe the vegetation diversity in the Dadia National Park an inventory of the habitat types in the sense of the Directive 92/43/EEC was carried out, based on a field survey by the authors.

The classification of habitat types was made, with minor modifications, following the syntaxonomy and synecological characterization that resulted from the identification, description and mapping of the Hellenic habitat types (Athanasiadis et al. 2001).

The implementation of the criteria and general methodology adopted by the Commission of the European Communities and described in respective Euro-

¹ For the altitudinal succession of the Mediterranean vegetation belts, the proposed system by Quezel and Barbero (1985) is followed.

Table 1. Main soil types of the Dadia National Park and surrounding areas. Source: Jones et al. (2005).

Soil type	Description
Be Eutric Cambisol Bv Vertic Cambisol	Soils moderately developed on account of limited age or rejuvenation of the soil material. Formerly referred to as brown soils, they occur in a wide variety of environments and under many kinds of vegetation. Common in Europe, can be very productive for forestry and agriculture. Eutric Cambisols show a base saturation of more than 50%. Vertic Cambisols have subsurface horizons of expanding clays.
Lc Chromic Luvisol	Soils with depleted surface clay which has been accumulated in a subsurface 'argic' horizon. They show high diversity originating from a wide range of parent materials and environmental conditions.
ld Dystric Leptosol	Shallow (<25 cm) eroded soils over hard rock or gravelly material. They are found mainly in areas where the soil has been eroded to the extent that hard rock comes near to the surface. Generally they do not have much structure due to their limited pedogenetic development.
Vcc Calcari-chromic Vertisol	Soils seasonally cracking, rich in swelling clay minerals. Calcareous at least 20–50 cm below surface, occur primarily in flat landscapes under climates with pronounced dry and wet seasons. Vertisols shrink and swell upon drying and wetting.
Soil types of the adjacent areas	
Im Molli-lithic Leptosol	Shallow eroded base-rich soils
Jc, Jcf Calcaric Fluvisols Je Eutric Fluvisols	Young alluvial soils on floodplains
Vp Pellic Vertisols Vpc Calcari-pellic Vertisols	Calcareous seasonally cracking soils
Wev Eutri-vertic Planosols	Base-rich soils with a bleached topsoil

pean Union manuals and handbooks (Commission of the European Communities 1991, Devillers and Devillers 1996, Commission of the European Communities 2003, 2007) was combined with the Hellenic references and habitat classification (Dafis et al. 2001).

Habitat types were syntaxonomically assigned to high-rank phytosociological syntaxa according to Horvat et al. (1974), Mucina (1997), Bergmeier and Dimopoulos (2008).

Based on the above criteria we assigned plant communities to nine habitat types which are described below. The habitats with the corresponding EU (Corine and Natura 2000 Interpretation Manuals) and Hellenic codification (Dafis et al. 2001) are provided in Table 3. A map showing the distribution of habitat types in the Park is provided in Fig. 2.

Habitat types

Juniperus oxycedrus arborescent matorral

This habitat type is comprised of sparsely developed scrub communities composed mainly of evergreen sub-

Mediterranean or Mediterranean species such as *Juniperus oxycedrus* subsp. *oxycedrus* and *Erica arborea*. It is a rather rare type in the DNP occurring only in one location in the northern part (Fig. 2). It occupies level ground at an altitude of 260 m forming open patchy clusters of shrubs with a height of 1–3 m. *Juniperus oxycedrus* arborescent matorral in the particular site constitutes vicarious vegetation succeeding the anthropogenic destruction of deciduous oak forest.

Other more or less common shrubs and semi-shrubs of this habitat type include *Prunus spinosa*, *Rosa pulverulenta*, *Rubus canescens* and *Cistus creticus*. The very rich and diverse flora of the herb layer includes *Dorycnium pentaphyllum* subsp. *herbaceum*, *Erodium cicutarium*, *Eryngium campestre*, *Galium verum*, *Hieracium baubinia*, *Hieracium cymosum*, *Leontodon cichoriaceus*, *Linum elegans*, *Moenchia mantica*, *Potentilla recta*, *Rumex acetosella*, *Sanguisorba minor*, *Scleranthus perennis*, *Helianthemum nummularium* subsp. *nummularium*, *Thymus longicaulis* subsp. *Chaubardii*, *Orchis papilionacea*, *Aira elegantissima*, *Anthemis arvensis*, *Anthoxanthum odoratum*, *Brachypodium sylvaticum*, *Helictotrichum convolutum* and *Luzula forsteri*.

Table 2. Characterization of the vegetation units according to the Map of the Natural Vegetation of Europe (Bohn and Neu-häusl.2000/2003).

Code	Vegetation type (as in Bohn and Neuhaüsl 2000/2003)
K22	Meso-Mediterranean to thermo-Mediterranean pine forests North Aegean <i>Pinus brutia</i> -forests with <i>Quercus frainetto</i> , <i>Quercus infectoria</i> , partly <i>Quercus coccifera</i> and <i>Arbutus andrachne</i> .
G28	South and east Balkan colline to montane (mixed) Balkan Oak forests Macedonian-Thracian Balkan Oak <i>Quercus frainetto</i> forests partly with <i>Carpinus orientalis</i> , <i>Juniperus oxycedrus</i> and <i>Paliurus spina-christi</i> , and with <i>Stipa bromoides</i> in the herb layer.
G57	South and east Balkan, as well as Crimean-west Caucasian colline Oriental Hornbeam-Downy Oak forests Albanian-Macedonian-Greek mixed Oriental Hornbeam-Downy Oak forests (<i>Quercus pubescens</i> , <i>Quercus virgiliana</i> , <i>Carpinus orientalis</i>) with <i>Symphytum ottomanum</i> , partly with <i>Phillyrea latifolia</i> , <i>Quercus coccifera</i> and <i>Asparagus acutifolius</i> .
F154	Montane-altimontane types, mostly with <i>Abies alba</i> , in southeast <i>Abies borisii-regis</i> , partly with <i>Picea abies</i> and other mixed tree species, with <i>Polygonatum verticillatum</i> Macedonian-Thracian beech and fir-beech forests (<i>Fagus sylvatica</i> subsp. <i>moesiaca</i> , <i>Abies borisii-regis</i> , <i>A. alba</i>) with <i>Pulmonaria rubra</i> .

This habitat is assigned as *Juniperus oxycedrus*-community without further syntaxonomical assignment.

Sub-continental steppic grasslands

Sub-continental steppic grasslands are dominated by several species of herbs and graminoids indicating moderately dry to mesophilous substrate conditions. This habitat type is quite rare in the park; it is present only in one location in the southern section of the park where it occupies a forest clearing on flat ground at 100 m altitude. The abundance and dense growth of herbaceous meadow vegetation as well as the lack of ligneous species are the main characteristics of this habitat type. Vegetation cover reaches almost 100% and the most common species include the perennials *Festuca valesiaca*, *Anthoxanthum odoratum*, *Chrysopogon gryllus*, *Helictotrichon aetolicum*, *Poa bulbosa*, *Poa trivialis*, *Ajuga genevensis*, *Daucus carota* subsp. *carota*, *Filipendula vulgaris*, *Hieracium cymosum*, *Luzula forsteri*, *Muscari comosum*, *Serapias vomeracea*, *Trifolium repens*, *Potentilla recta*, *Rorippa pyrenaica*, *Linum hologynum*, *Oenanthe tenuifolia* and the annuals *Trifolium campestre*, *Aira elegantissima*, *Moenchia mantica*, *Juncus minutulus* and *Myosotis sicula*. Along with the presence of *Orchis laxiflora* subsp. *palustris* they indicate a local transition to a more mesophilous substrate.

Syntaxonomic classification (Athanasiadis et al. 2001) resulted in a *Festuca valesiaca*–*Trifolium campestre*-com-

munity which is assigned to the European subcontinental grasslands of the order Festucetalia valesiaca and the class Festuco-Brometea.

Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea

This habitat type is comprised of open xerophilous grasslands on poor sites with eroded soils and rocky substrate. It is the most abundant and widespread type of grassland covering approximately 2.5% of the total area in the park at an altitudinal range varying between 150 and 280 m. Pseudo-steppic grasslands are found in pine forest clearings and are typically forming a low-layered vegetation of short herbs and grasses growing in patches where fine soils occur. Floristic composition includes a relatively high proportion of therophytes such as *Aira elegantissima*, *Avena sterilis*, *Briza maxima*, *Bromus rubens*, *Taeniatherum caput-medusae*, *Legousia speculum-veneris*, *Petrorhagia prolifera*, *Sherardia arvensis*, *Trifolium cherleri*, *Trifolium stellatum*, *Trifolium lappaceum*, *Trifolium arvense*, *Trifolium campestre*, *Tuberaria guttata*, *Linaria pelisseriana* and *Centaurea cyanus*. Other common species include *Anthoxanthum odoratum*, *Asphodelus ramosus*, *Convolvulus cantabrica*, *Eryngium campestre*, *Leontodon hispidus*, *Poa bulbosa*, *Chrysopogon gryllus*, *Teucrium capitatum* and *Thymus comptus*, with the occasional presence of the shrubs *Paliurus spina-christii* and *Phillyrea latifolia*.

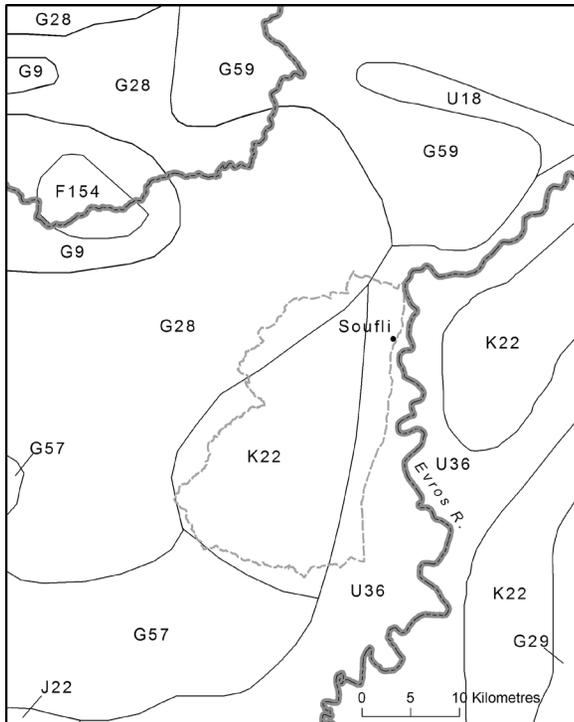


Fig. 2. Map of the main plant formations of Dadia–Lefkimi–Soufli National Park (modified after Bohn and Neuhäusl 2000/2003).

This habitat type is classified in the *Tuberaria guttata*-*Genista sericea*-community which could be assigned to the Thero-Brachypodietea and Thero-Brachypodietalia class and order, respectively.

Thermophilous oak woods of the Eastern Mediterranean and the Balkans

Thermophilous oak woods comprise typical Balkan communities of subcontinental deciduous *Quercus* species which in Dadia are *Q. frainetto*, *Q. pubescens*, *Q. cerris* and *Q. petraea* subsp. *medwediewii*. They are distributed mainly in the northern and southwestern parts of the forest complex; they constitute the second most extensive habitat type, covering a little less than half of the total forested area and approximately 31% of the DNP. Deciduous oak forest communities are distributed at altitudes ranging from 40 to 470 m and occur on a variety of rock substrata. They grow on soils finer in texture and richer in nutrients than the pure pinewoods do. They generally consist of low, coppiced stands of approximately 20–60 years. A more or less irregular structure of the forest must be ascribed to former mismanagement and irrational exploitation. Dadia oak forests as well as its pinewoods have been subjected to Forest Service management plans only during the last 40 years. The current forest management plan aims at converting the coppiced oak stands to tall forest originating from seedlings.

The most frequently dominating oak species in DNP is *Quercus frainetto*; often *Quercus cerris* and *Quercus petraea* co-occur as individuals or mixed groups. *Quercus pubescens* is also a common component of the oak forest habitats being present mainly in the warmer, dryer and somehow degraded sites. *Pinus halepensis* subsp. *brutia* may also invade and establish in open oak clumps both as individuals and as groups but this spe-

Table 3. Description of habitat types and corresponding European and Hellenic codification. (*) indicates priority habitat type of Annex I, 92/43/EEC.

Corine code	Natura 2000 code	Hellenic code	Habitat description
32.131	5210	5211	<i>Juniperus oxycedrus</i> arborescent matorral
34.31	–	–	Sub-continental steppic grasslands
34.532	6220 *	–	Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea
41.76	91M0 & 91AA	924A	Thermophilous oak woods of Eastern Mediterranean and Balkans
32.313	–	–	Eastern Mediterranean high maquis
42.66	9530 *	9536	(Sub-)Mediterranean pine forests with endemic black pines
42.85	9540	–	Mediterranean pine forests with endemic Mesogean pines
44.514	91E0 *	–	Greek alder galleries
44.1412	92A0	–	<i>Salix alba</i> and <i>Populus alba</i> galleries

cies has difficulty in penetrating under a closed shady oak canopy.

A floristically rich understory is always present in the oak forests and comprises characteristic taxa that distinguish the high-rank syntaxa: *Quercetea pubescentis*, *Quercetalia pubescentis*, *Quercion frainetto* (Mucina 1997, Bergmeier and Dimopoulos 2008). Dominants among low trees and shrub include: *Rubus canescens*, *Carpinus orientalis*, *Phillyrea latifolia*, *Fraxinus ornus*, *Juniperus oxycedrus* subsp. *oxycedrus*, *Erica arborea*, *Cistus creticus* subsp. *creticus*, *Genista carinalis*, while *Sorbus domestica*, *Sorbus torminalis*, *Acer monspessulanum*, *Acer campestre*, *Chamaecytisus hirsutus*, *Arbutus andrachne*, *Cornus mas* and *Genista sericea* occur occasionally. The herbaceous understory includes an assemblage of the habitat's typical species: *Lathyrus laxiflorus*, *Potentilla micrantha*, *Trifolium pignanii*, *Lathyrus niger*, *Silene coronaria*, *Euphorbia amygdaloides* subsp. *amygdaloides*, *Lapsana communis*, *Dactylis glomerata*, *Brachypodium sylvaticum*, *Campanula persicifolia*, *Festuca varia*, *Carex flacca*, *Galium mollugo* agg., *Hieracium hoppeanum*, *Hieracium baubini* agg., *Trifolium ochroleucon*, *Thymus longicaulis* subsp. *chaubardii* and *Clinopodium vulgare*.

A single pure stand of *Quercus petraea* subsp. *medwediewii* occurs in a relatively cool site located in the northern sector of the park near the village Giannouli (Ada-Tepe hill). It is found at an elevation of 450 – 470 m on a north-east facing slope and is characterised by the presence of a well-developed herb layer and a lack of woody species. Most abundant species are *Campanula persicifolia*, *Anthoxanthum odoratum*, *Festuca heterophylla*, *Galium mollugo* agg., *Hieracium latifolium* agg. and *Anthemis tinctoria* subsp. *parnassica*.

Additionally, the presence of a local transition on the Gibraina hilltop ranging from pure *Quercus* spp. and mixed *Quercus* spp.-*Pinus nigra* forest to an *Acer platanoides*-*Tilia tomentosa* community is noteworthy. On steep slopes of northern exposure that consist of coarse scree, zonal oak woodland fringes mixed deciduous forest. Dominant tree species are *Tilia tomentosa* and *Acer platanoides* with *Rhus coriaria*, *Cotinus coggygria* in the shrub layer. This vegetation type should be investigated further to be classified; it may be assigned to either the Tilio-Acerion xerothermophilous sub-alliance of lime-maple dominated forests belonging to the Tilio-Acerion forests of slopes, dry warm scree and talus cones (habitat type 9180) or classified as a *Tilia tomentosa*-dominated facies within the range of Balkan thermophilous oak-woods. In the latter case it could be assigned to the habitat “Moesian silver lime woods” (91Z0). In any case it comprises a habitat of exceptional biological value and

rarity (9180 is a priority habitat type for the EU) which increases the species and community diversity of the area dramatically. The remaining thermophilous oak forests may be assigned directly to the category 924A “Thermophilous oak woods of Eastern Mediterranean and Balkans” of the Hellenic catalogue. They could also be partly assigned (according to the several *Quercus* species) to the types 91M0 “Pannonian-Balkan Turkey oak-sessile oak forests” and 91AA “Eastern white oak woods”. Syntaxonically it could be assigned to the alliance *Quercion frainetto* (= *Quercion confertae*), the order *Quercetalia pubescentis* and the class *Quercetea pubescentis*.

Eastern Mediterranean high maquis

This habitat type represents relatively warmer and dryer conditions than for the development of broadleaved vegetation. It comprises sclerophyllous mostly evergreen scrub communities that exhibit a rather extra-zonal character and could be identified as a transitional phase from meso-Mediterranean to the supra-Mediterranean vegetation belts. The altitudinal range is from 200 to 450 m in the south-western section of the park, where it covers c. 2% of the surface area amongst or adjacent to thermophilous oak forests. Acidic and very often shallow rocky soil developed on flysch or gneiss (*rankers*) favours the occurrence of this particular vegetation type.

From a structural viewpoint the habitat consists of low to moderately high (1.5 to 3 m), mostly dense scrub dominated by evergreen species such as *Arbutus andrachne*, *Phillyrea latifolia*, *Erica arborea*, *Cistus creticus* subsp. *creticus* and *Cistus salviifolius*. Frequent but less dominant evergreen species include *Pistacia terebinthus* and *Juniperus oxycedrus* subsp. *oxycedrus*.

This habitat is considered to be of particular significance as an extra-zonal type of sclerophyllous vegetation that also contributes to the ecological stability and protection of the infertile and degraded sites where it occurs. Due to its importance, protection measures against habitat loss because of possible establishment of plantations with exotic and indigenous pines are necessary.

Syntaxonically this type could be assigned to the *Arbutus andrachne*-*Phillyrea latifolia* community of the *Quercetea* and *Quercetalia pubescentis* class and order.

(Sub-)Mediterranean pine forests with endemic Black Pines

Pinus nigra subsp. *nigra* var. *caramanica* (= *Pinus nigra* subsp. *pallasiana* = *Pinus pallasiana*) is a montane-Med-

iterranean conifer generally found at high altitudes in mountain regions in the rest of the country. However, in the DNP scattered Black Pines are found as low as at 110 m asl, favoured by the region's continental character. Black Pine woodland is considered a particularly rare habitat type in the area. At certain favourable sites *Pinus nigra* forms part of the canopy layer, individually or in groups mixed with *Quercus* species or *Pinus halepensis* subsp. *brutia*. It occurs in pure stands only in two small patches south of the village of Dadia. There it occupies level ground with sandy and acidic soil. It forms a quite open tree canopy with a densely developed herb layer. Graminoids like *Anthoxanthum odoratum*, *Briza maxima*, *Dactylis glomerata*, *Cynosurus echinatus*, *Holcus lanatus*, *Stipa bromoides*, *Chrysopogon gryllus*, *Danthonia alpina*, *Brachypodium sylvaticum*, *Luzula forsteri* and *Carex flacca* are found in abundance while *Pteridium aquilinum* subsp. *aquilinum*, *Cistus creticus* subsp. *creticus*, *Rubus canescens*, *Thymus longicaulis* subsp. *chaubardii*, *Thymus atticus*, *Genista carinalis*, *Hypericum rochelii*, *Hypericum olympicum*, *Galium verum*, *Origanum vulgare*, *Clinopodium vulgare* and *Campanula persicifolia* are co-occurring species.

Black Pine habitats are syntaxonomically classified as a *Pinus nigra* subsp. *pallasiana* community assigned to the Quercetea pubescentis class and the Quercetalia pubescentis order.

Mediterranean pine forests with endemic Mesogean pines

In this habitat type *Pinus halepensis* subsp. *brutia* (= *Pinus brutia*) forests are included. They extend mainly in the middle, eastern and southern sections of the DNP, where pure stands cover approximately 47% of the total forested area. *Pinus halepensis* subsp. *brutia* stands are of medium age (40–80 years) and mostly grow on acidic sandy soils developed on granite or volcanic tuff. Although *Pinus halepensis* subsp. *brutia* in optimum environmental conditions exhibits vigorous growth and may reach a height of 25–30 m, in Dadia it has a generally low productivity and slow growth rate due to the nutrient-poor substrate. Nevertheless, the dominance of hardy and drought tolerant pines in poor sites has been particularly favoured by former human activities and mismanagement practices, i.e. fire incidents combined with arbitrary grazing and logging, especially during the war periods. These factors in combination with site parameters have contributed to the expansion of *Pinus halepensis* subsp. *brutia* forest over deciduous oaks. Despite this, *Quercus* species in the majority of sites grow

in the moderately shady understory of the pine forest. They usually form a scattered secondary canopy or a conspicuous shrub layer along with *Phillyrea latifolia*, *Juniperus oxycedrus* subsp. *oxycedrus*, *Fraxinus ornus* and occasionally *Erica arborea*, *Jasminum fruticans*, *Arbutus andrachne* and *Cornus mas*. The herb layer is moderately or poorly developed depending on light availability and soil quality. These forests floristically reflect communities of warm and dry sites. Common species include *Stipa bromoides*, *Aira elegantissima*, *Briza media*, *Carex flacca*, *Bromus sterilis*, *Origanum vulgare*, *Tuberaria guttata*, *Ornithopus compressus*, *Trifolium angustifolium*, *Trifolium arvense*, *Hieracium baubini*, *Brachypodium pinnatum*, *Dorycnium hirsutum*, *Teucrium chamaedrys*, *Thymus longicaulis* subsp. *chaubardii*, *Viccia cracca*, *Dactylis glomerata*, *Ruscus aculeatus*, *Rubus canescens*, *Limodorum abortivum*, *Cistus creticus* subsp. *creticus* and *Genista carinalis*.

In the medium term, oak species are expected to become both more regular and more abundant as members of the canopy of the pinewoods in sites with optimal ecological conditions. The pure pine stands could be assigned to the *Pinus halepensis* subsp. *brutia*-community and can syntaxonomically be classified in the class Quercetea ilicis and the order Quercetalia ilicis.

Riparian habitats

Riparian vegetation is distributed on alluvial deposits along streams and water courses, where they form multi-layered arborescent galleries. Two habitat types can be distinguished on the basis of their dominant tree species, alder galleries and *Salix-Populus* galleries.

Greek alder galleries. This vegetation type forms corridors and galleries inside zonal woodlands, along streams with low inclination (~ 5%) at elevations ranging from 100 to 300 m. The canopy of these riparian forests consists of tall, almost pure *Alnus glutinosa*, while the assorted understory at places comprises a dense shrub and herb layer. The abundance of climbers such as *Periploca graeca*, *Vitis vinifera* subsp. *sylvestris*, *Hedera helix* subsp. *helix*, *Tamus communis* and *Clematis vitalba* is worth noting.

The herb layer of *Alnus glutinosa* riparian communities includes many tall forb species such as *Equisetum arvense*, *Carex acuta*, *Cyperus longus*, *Juncus articulatus*, *Lycopus europaeus*, *Mentha spicata*, *Lythrum salicaria*, *Lysimachia punctata*, *Urtica dioica*, *Eupatorium cannabinum*, *Holcus lanatus*, *Inula salicina*, *Pulicaria dysenterica*, *Lycopus europaeus*, *Lysimachia nummularia*, *Gratiola officinalis*, *Calamagrostis epigeios* and *Melissa officinalis*.

The *Alnus glutinosa* galleries are assigned to the Corine habitat type 44.514 “Greek alder galleries” and could also be assigned to the Natura 2000 priority habitat type 91E0 “Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)” though not belonging to the referred alliances. Syntaxonomically they are classified in the *Alnus glutinosa*-community assigned to the alliance Populion albae, the order Populetalia albae and the class Querco-Fagetea.

Salix alba and *Populus alba* galleries. *Salix alba* and *Populus alba* form very narrow galleries at altitudes between 30 and 60 m asl in the agricultural area of Dadia and more specifically along the river banks of Diavolorema, which is a tributary to Evros in the eastern part of the park. The tree layer is very often fragmented and consists of *Salix alba*, *Populus alba*, *Populus nigra*, *Fraxinus angustifolia*, *Alnus glutinosa* and *Salix amplexicaulis*. Climbers such as *Periploca graeca*, *Vitis vinifera* subsp. *sylvestris*, *Calystegia sepium*, *Rubus sanctus*, *Clematis vitalba*, *Tamus communis* and *Hedera helix*, subsp. *helix* are very abundant and show high concentrations locally. Various shrub and herb species in the understory of the *Salix alba* and *Populus alba* woods originate from open places in the surroundings (roads and cultivations).

According to the dominant tree species this habitat type is classified in the association Salicetum albae, the alliance Salicion albae, the order Salicetalia purpureae and the class Salicetea purpureae.

Forest plantations

Coniferous plantations occur in the southern section of the park. Formerly burnt areas near the Kitrinopetra and Lefkimi settlements, barren land in the south-western section of the park and sparsely wooded areas with sclerophyllous scrub and thickets have been reforested with coniferous trees. Coniferous plantations are protected for several years after their establishment and according to the Forest Service their main aim is site rehabilitation, soil protection and future timber production. For this purpose *Pinus halepensis* subsp. *brutia* and the exotic *Pinus maritima* have been planted.

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