ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS

PROGRAMME
&
BOOK OF ABSTRACTS

International Conference
'Conservation, Regeneration and Restoration of
Mediterranean Pines and their Ecosystems'

MEDPINE 2

Chania, Crete, Sep. 8-13, 2002

Co-organized by the University of Athens, MAICh and the Hellenic Ministry of Agriculture

Athens, September 2002

Acknowledgements

I express my sincere gratitude to the co-organisers of MEDPINE 2: the Hellenic Ministry of Agriculture, Greece (Mr Georgios Dris, Minister & Mr Fotis Chatzimichalis, Vice Minister), the University of Athens (and especially Prof. Michalis Dermitzakis, Vice Rector) and the Mediterranean Agronomic Institute at Chania (Mr Alkinoos Nikolaidis, Director). I also thank the Ministry of Culture, Greece, the Printing Department of the University of Athens, the Civil Protection Service of Chania (Mr Manolis Bouzakis), the Directorate of Forests, Chania (Mr Vasilios Kasiotakis and Dr Haroula Kargiolaki), the Archaeological Museum of Chania (Ms Maria Vlazaki, Director) and the Conference Center of MAICh (Ms Roulie Zervou, Ms Katerina Karapataki, Ms Christina Protopapadaki, Ms Athanasia Mavrommati, Ms Maria Giannakaki). Finally, I thank all the colleagues of the International Scientific Board for their help in shaping MEDPINE 2 as well as all my collaborators (Dr Maria Doussi & Mr Petros Panayiotopoulos at the Univ. of Athens, Dr Evangelia Daskalakou at the Mediterranean Forest Institure, Athens and Ms Christina Fournaraki at MAICh). A special word of thanks to our artist, Ms Ioanna Daskalakou (painter, Athens School of Fine Arts) who has drawn the logo of the Conference.

Costas A. Thanos
September 2002

ΕΘΝΙΚΟΝ & ΚΑΠΟΔΙΣΤΡΙΑΚΟΝ ΠΑΝΕΠΙΣΤΗΜΙΟΝ ΑΘΗΝΩΝ
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hellenic ministry of agriculture

MAICh

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International Scientific Board

Costas A. Thanos (University of Athens, Greece) **chair**
Margarita Arianoutsou (University of Athens, Greece)
Melih Boydak (University of Istanbul, Turkey)
Spyros Dafis (GBWC Thessaloniki, Greece)
Gidi Ne'eman (University of Haifa, Israel)
Vittorio Leone (University of Basilicata, Italy)
Louis Trabaud (CNRS Montpellier, France)
Ramon Vallejo (CEAM Vallencia, Spain)

PROGRAMME

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PROGRAMME

Sunday 8 September

18:00-20:00 **Registration MEDPINE 2**

19:00-21:00 **Welcome Reception**

Monday 9 September

09:00-09:30 **Registration MEDPINE 2**

Monday 9 September

09:30-10:30 OFFICIAL OPENING

Chair: **The International Scientific Board**

Alkinoos Nikolaidis
(Director, Mediterranean Agronomic Institute of Chania)
Welcome address

Opening Addresses

Prof. Michalis Dermitzakis
(Vice Rector, University of Athens, Athens, Greece)
Official Opening of the Conference

10:00-10:30 **(Introductory Lecture)**
G. Hadjikyriakou[1] and C.A. Thanos[2]
([1]Forestry Service of Cyprus, [2]Univ. Athens - Greece)
Theophrastus on Pines

10:40-11:20 Coffee Break

Monday 9 September
11:20-13:00 SESSION 1

chair: **Margarita Arianoutsou (Greece) – Gabriel Schiller (Israel)**

11:20-12:00 **(Review Lecture)**
K.P. Panetsos
(Univ. Thessaloniki - Greece)
Natural and artificial hybridization between *Pinus brutia* X *Pinus halepensis*. Consequences for conservation and tree breeding

12:00-12:20
F.A. Aravanopoulos, K.P. Panetsos and A. Skaltsoyiannes
(Univ. Thessaloniki - Greece)
Genetic structure of *Pinus brutia* stands exposed to wildfires

12:20-12:40

K. Işik[1], S. Keskin[2], F. Işik[2,3] and Y. Cengiz[2]
([1]Akdeniz University, [2]Southwest Anatolia Forest Research Institute - Turkey [3]North Carolina State University - USA)
Clonal variation of flower production in a *Pinus brutia* seed orchard

12:40-13:00
P.V. Petrakis[1], V. Roussis[2] and A.H. Ortiz[3]
([1]NAGREF - Greece, [2]Univ. Athens - Greece, [3]Univ. Jaen - Spain)
Is hybridization of Mediterranean pines an escape strategy from insects in evolutionary time?

13:00-14:30 Lunch

Monday 9 September
14:30-16:30 SESSION 2

chair: **Gidi Ne'eman (Israel) - Maria Doussi (Greece)**

14:30-14:50
J. Martínez-Vilalta[1], A. Sala[2] and J. Piñol[1]
([1]CREAF/ Universitat Autònoma de Barcelona - Spain, [2]University of Montana - USA)
The hydraulic architecture of Pinaceae

14:50-15:10
G. Schiller and N. Atzmon
(ARO, The Volcani Center - Israel)
Ecophysiological properties of Aleppo pine provenances under severe drought

15:10-15:30
Teobaldelli M.[1], Mencuccini M.[2], Piussi P.[1]
([1]Florence University, Italy; [2]I.E.R.M, Edinburgh University, UK)
Water table salinity, rainfall and water use by umbrella pine trees (*Pinus pinea* L.)

15:30-15:50

M. De Luís[1], J. Raventós[1], J.C. González-Hidalgo[2] and M.J. Gras[1]
([1]Univ. Alicante, [2]Univ. Zaragoza - Spain)

Growth dynamic of *Pinus halepensis* in a rainfall gradient of the region of Valencia (Spain)

15:50-16:10

J. Raventós[1], M. De Luís[1], M.J. Gras[1], K. Čufar[2], J.C. González-Hidalgo[3], A. Bonet[1] and J.R. Sánchez[1]
([1]Univ. Alicante - Spain, [2]Univ. Ljubljana - Slovenia, [3]Univ. Zaragoza - Spain)

Growth anomalies on *Pinus pinea* and *Pinus halepensis* corresponding to dryness and marine spray episodes

16:10-16:30

J.C. González-Hidalgo[1], J. Raventós[2] and M. De Luís[2]
([1]Univ. Zaragoza, [2]Univ. Alicante - Spain)

Relationship between NAO teleconnection pattern and *P. halepensis* growth in western Mediterranean basin

16:30-16.55 Coffee Break

16:55 **Group Photo**

Monday 9 September

17:00-18:40 SESSION 3

chair: **Ramon Vallejo (Spain) - Filippos Aravanopoulos (Greece)**

17:00-17:20

T.L. Bell and M.A. Adams
(Forest Science Center - Australia)

Ecophysiology of ectomycorrhizal fungi associated with *Pinus* in western Australia

17:20-17:40

M. Tsakaldimi
(Univ. Thessaloniki - Greece)

Effect of growing media on biomass accumulation and nutrient concentrations of containerized *Pinus halepensis* seedlings

17:40-18:00

P. Villar-Salvador, S. Domínguez-Lerena, J.L. Peñuelas and Inmaculada Carrasco
(Centro Nacional de Mejora Forestal "El Serranillo" - Spain)

Plant morphology and outplanting performance relationships in Mediterranean *Pinus* species

18:00-18:20
F. Iovino[1], G. Menguzzato[2] and A. Nicolaci[2]
([1]Università della Calabria, [2]Università di Reggio Calabria - Italy)
Structural analysis of the Calabrian pine forests in Sila mountains (southern Italy)

18:20-18:40
J. Climent and L. Gil
(ETSI de Montes (UPM) - Spain)
Life history of Canary Islands pine (*Pinus canariensis* Chr. Sm.) in its natural range of distribution

Tuesday 10 September

Tuesday 10 September
9:00-11:00 SESSION 4

chair: **Vittorio Leone (Italy) - Thekla Tsitsoni (Greece)**

9:00-9:40 **(Review Lecture)**
M. Arianoutsou
(Univ. Athens - Greece)
Ecological indicators of post-fire resilience in *Pinus halepensis* forests

9:40-10:00
D. Kazanis and M. Arianoutsou
(Univ. Athens - Greece)
Long-term post-fire vegetation dynamics in *Pinus halepensis* forests of central Greece: a functional-group approach

10:00-10:20
E.N. Daskalakou and C.A. Thanos
(Univ. Athens - Greece)
Postfire regeneration of Aleppo pine – seedling emergence temporal patterns

10:20-10:40
Eric Rigolot
(INRA - France)
Predicting postfire mortality of *Pinus halepensis* and *Pinus pinea*

10:40-11:00
C.A. Thanos, E.N. Daskalakou, A. Skordilis, P. Panayiotopoulos and M.A. Doussi
(Univ. Athens - Greece)
Dynamics of growth and reproduction in postfire regenerating Aleppo pines (Mt Parnes, 1989-2002)

11:00-11:30 Coffee Break

Tuesday 10 September
11:30-13:10 SESSION 5

chair: **Melih Boydak (Turkey) - Evangelia Daskalakou (Greece)**

11:30-11:50
G. Ne'eman and S. Goubitz
(Univ. Haifa-Oranim - Israel)
Reproductive traits of *Pinus halepensis* in the light of fire

11:50-12:10
M.A. Doussi and C.A. Thanos
(Univ. Athens - Greece)
The mechanism of cone opening in *Pinus halepensis* and *P. brutia* – morphology and physiology

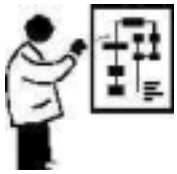
12:10-12:30
T. Zagas, P. Ganatsas, T. Tsitsoni and A. Hatzistathis
(Univ. Thessaloniki - Greece)
Postfire regeneration of Aleppo pine ecosystems in Sithonia peninsula, north Greece

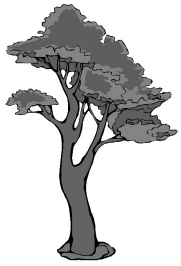
12:30-12:50
T. Neyisci
(Univ. Akdeniz, Antalya - Turkey)
The ecological role of fire for the sound management of *Pinus brutia* Ten. ecosystems

12:50-13:10
T. Tsitsoni, T. Zagas and P. Ganatsas
(Univ. Thessaloniki - Greece)
Dynamics of postfire regeneration of *Pinus brutia* in periurban forest of Thessaloniki, north Greece

13:10-14:30 Lunch

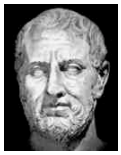
Tuesday 10 September
14:30-16:30
POSTER VIEWING SESSION A





16:30-21:00 **Half-Day Excursion**
Omalos Plateau – Cypress forests – Prasses vilage (infected *Pinus brutia* forest)

Wednesday 11 September



8:30-11:00
Visit to the Archaeological Museum of Chania

11:00-11:30 Coffee Break

Wednesday 11 September
11:30-13:00 SESSION 6

chair: **George Hadjikyriakou (Cyprus) - Ioannis Spanos (Greece)**

11:30-12:10 (**Review Lecture)**
R. Vallejo[1], A. Valdecantos[1], F. Maestre[2], C. Bladé[1], S. Bautista[1], and J. Cortina[2]
([1]CEAM, Parque Tecnologico, Paterna, [2]Dep. Ecologia, Univ. Alacant – Spain)
Reforestation with Mediterranean pines: new perspectives for an old practice

12:10-12:30
O. Ciancio[1], V. Garfì[2] and S. Nocentini[1]
([1]Università di Firenze, [2]Università di Reggio Calabria - Italy)
Huffel's "Fûtaie Claire": a silvicultural and management system for stone pine (*Pinus pinea* L.) woods

12:30-12:50
P.P. Ganatsas, T.K. Tsitsoni and T.D. Zagas
(Univ. Thessaloniki - Greece)
Restoration of degraded ecosystems in the association of Cocciferetum using Mediterranean conifers

13:00-14:30 Lunch

Wednesday 11 September
14:30-16:30 SESSION 7

chair: **Tina L. Bell (Australia) - Theocharis Zagas (Greece)**

14:30-14:50
Melih Boydak
(Univ. Istanbul - Turkey)
Variations, silvicultural characteristics and natural regeneration of

***Pinus brutia* Ten.**

14:50-15:10

Ç. Tavşanoğlu, B.Y. Kaynaş and B. Gürkan
(Univ. Hacettepe, Ankara - Turkey)
Early postfire regeneration of a *Pinus brutia* forest in Marmaris National Park, Turkey

15:10-15:30

I. Spanos and Y. Raftoyannis
(Forest Research Institute, Thessaloniki - Greece)
Postfire management activities and their effects on *Pinus brutia* - *P. halepensis* forests

15:30-15:50

L. Trabaud
(Centre d'Ecologie Fonctionnelle et Evolutive, CNRS - France)
Comparison of the distribution pattern between post-fire seedlings of *Pinus halepensis* and *P. nigra* subsp. *salzmannii*

15:50-16:10

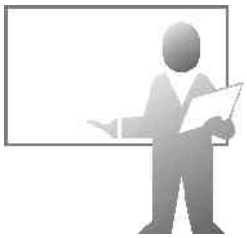
M.J. Gras, M. De Luís, J.R. Sánchez, A. Bonet and J. Raventós
(Univ. Alicante - Spain)
Seed establishment of *Pinus pinea* and *Pinus halepensis* in a semiarid sand dune ecosystem of Spain

16:30-17:00 Coffee Break

Wednesday 11 September

17:00-18:20 SESSION 8

***chair:* Jose Climent (Spain) - Eric Rigolot (France)**



17:00-17:40 **(Review Lecture)**

V. Leone
(Univ. Basilicata - Italy)
Conservation of Mediterranean pine woodlands

17:40-18:00

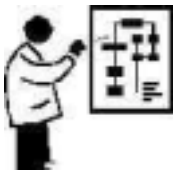
A. Perevolotsky
(Israel Nature and Parks Authority, Jerusalem & Dept. of Natural Resources, Agr. Res. Org.-Volcani Center - Israel)
Conservation and management of *Pinus halepensis* in Israel: an ecological basis for a national program

18:00-18:20

M.A. Zavala
(Univ. Alcalá - Spain)
Pattern and process in Iberian mixed pine-oak forests: insights on coexistence mechanisms of Mediterranean plant communities

21:00 **Gala Dinner**

Thursday 12 September



09:00-11:00
POSTER VIEWING SESSION B

11:00-11:30 Coffee Break

Thursday 12 September
11:30-13:30 COMMON SESSION MEDPINE 2 & TREE SEEDS 2002

Chair: **Louis Trabaud (France) - Haroula Kargiolaki (Greece)**

11:30-12:10 **(MEDPINE 2 – Review Lecture)**
R. Nathan
(Ben-Gurion University of the Negev - Israel)
Spatiotemporal dynamics of recruitment in Aleppo pine

12:10-12:30 (MEDPINE 2)
F. Krouchi[1], K. Tahir[1], R. Aba[1], A. Raffin[2] and M. Rezzig[3]
([1]Université M. Mammeri de Tizi-ouzou - Algeria, [2]INRA - France, [3]Institut National de recherche forestière - Algeria)
Variation in cone and seed characteristics of *Pinus pinaster* Ait. in Algeria

12:30-12:40
C. Fournaraki
(Mediterranean Agronomic Institute of Chania - Greece)
The Plant Conservation Unit at MAICh – Herbarium, Seed Bank, Botanical Garden

12:40-12:50
K. Thompson
(Treasurer of ISSS / University of Sheffield - UK)
A brief presentation of the International Society for Seed Science (ISSS)

12:50-13:20
Manolis Bouzakis
(Civil Protection Service, Prefecture of Hania)
Hania – the place, the history, the people

13:30-15:00 Lunch

Thursday 12 September
15:00-16:30 SESSION 10

chair: **The International Scientific Board**

General Discussion
Concluding Comments and Remarks
Venue of next MEDPINE 3
Thanks and goodbyes

16:30-17:00 Coffee Break

17:00-22:00 **Chania City Tour**

Friday 13 September

6:30-21:00 **Excursion to the National Park of Samaria Gorge**

POSTERS

D. Abdelli, A. Derridj and A. Asmani
(Université Mouloud Mammeri Tizi-Ouzou - Algeria)
Germination of *Pinus nigra* subsp. *mauretanica* (Algeria)

N. Aksoy
(University of Istanbul - Turkey)
The distribution of *Pinus brutia* Ten. (Red Pine) and its morphological and floristic structure in upper Menderes river basin (Çivril-Denizli)

R. Alejano Monge[1] and E. Martínez Montes[2]
([1]Universidad de Huelva, [2]Consejería de Medio Ambiente, Junta de Andalucía - Spain)
***Pinus nigra* Arn. ssp. *salzmannii* relict spots in south-eastern Spain**

R. Alejano Monge[1] and E. Martínez Montes[2]
([1]Universidad de Huelva, [2]Consejería de Medio Ambiente, Junta de Andalucía - Spain)
Influential factors on natural regeneration of *Pinus nigra* Arn. ssp. *salzmannii* in the Cazorla mountain range (south-eastern Spain)

G. Barbera, T. La Mantia, D.S. La Mela Veca, F. Maetzke and G. Garfì
(University of Palermo - Italy)
Overview on the afforestation activity in Sicily in the last 40 years: results and perspectives

M.R. Chambel and R. Alia
(Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria - Spain)
Phenotypic plasticity in Mediterranean pines (*Pinus pinaster, Pinus halepensis* and *Pinus nigra*)

J. Climent, J. Alonso and L. Gil
(ETSI de Montes (UPM) - Spain)
Variation of needle anatomy in *Pinus canariensis*

S. Dominguez-Lerena, I. Carrasco and J.L. Peñuelas
(Centro Nacional de Mejora Forestal "El Serranillo" - Spain)
Nursery and field growth of *P. halepensis* seedlings fertilised in the nursery with different amounts of N, P and K

S. Dominguez-Lerena, N. Herrero, I. Carrasco and J.L. Peñuelas
(Centro Nacional de Mejora Forestal "El Serranillo" - Spain)
Can the container type influence the outplanting performance of *Pinus halepensis* and *Pinus pinea* seedlings?

S. Dominguez-Lerena[1], J. Oliet[2], I. Carrasco[1] and J.L. Peñuelas[1]
([1]Centro Nacional de Mejora Forestal "El Serranillo", [2]Universidad de Cordoba - Spain)
Nursery and field growth of *P. pinea* seedlings fertilised in the nursery with different amounts of N, P and K

M.V. Durán-Carril, J.A. Vega[1], P. Pérez-Gorostiaga, T. Fonturbel, P. Cuiñas and M. Alonso
([1]Centro de Investigaciones Forestales y Ambientales-Lourizan, Pontevedra – Spain)
The effects of thinning in seedlings of post-fire *Pinus pinaster* Ait. regeneration on carbohydrate storage contents

M. Fernández Fernández[1] and J.M. Salgado Costas[2]
([1]Universidad de Valladolid, [2]Universidad de León - Spain)
Recolonization of a *Pinus pinaster* stand by carabid beetles after a wildfire

N. Henig-Sever and G. Ne'eman
(University of Haifa-Oranim - Israel)
The effect of logging on post-fire regeneration of natural *Pinus halepensis* forest

Y. Icgen[1,2], B. Cengel[1,2], E. Velioglu[1], H. Ozturk[1] and Z. Kaya[2]
([1]Forest Tree Seeds and Tree Breeding Research Directorate, [2]Middle East Technical University - Turkey)
Comparison of rapid variation between *Pinus brutia* Ten. seed stands and plantations from Turkey

K. Karagiannis
(Aristotle University of Thessaloniki - Greece)
Environment-friendly construction of forest roads in *Pinus brutia* forests

T. La Mantia, G. Garfì, S. Cullotta, S. Pasta and M. Marchetti
(University of Palermo - Italy)
A survey on the effect of fire on the behaviour of autochthonous pines in Sicily, with special reference to the re-colonisation processes performed by Mediterranean species

V. Leone, A. Saracino and G. Maiullari
(University of Basilicata - Italy)
Post fire rehabilitation of *Pinus halepensis* Mill. stands and their treatments: a case study

A. Madmony[1], D. Brand[2], Z. Kuller[3], L. Korol[1], A. Zehavi[2], Y. Moshe[1], A. Eizenband[2] and S. Lev-Yadun[4]
([1]A.R.O., the Volcani Center, [2]Jewish National Fund, [3]Nature and Parks Authority, [4]University of Haifa - Israel)
***In-situ* and ex-*situ* conservation of an old natural stand of *Pinus halepensis* in "ha'Masrek" reserve in Israel**

R. Mercurio
(Mediterranean University of Reggio Calabria and Aspromonte National Park - Italy)
Forest dynamics in cluster pine (*Pinus pinaster* Ait.) stands in Tuscany (central Italy)

R. Mercurio, G. Modica and G. Spampinato
(Mediterranean University of Reggio Calabria and Aspromonte National Park - Italy)
Forest types in Calabrian pine (*Pinus laricio* Poiret) stands in the Aspromonte national park

T. Neyisci
(Akdeniz University - Turkey)
Prescribed burning as a fuel management tool in *Pinus brutia* Ten. forest ecosystems around Antalya / Turkey

A. Noy-Meir, A. Perevolotsky, Y. Noy-Meir and J. Kigel
(Hebrew University of Jerusalem & Volcani Institute – Israel)
Germination of *Pinus halepensis* in natural habitats

H. Öztürk[1] and K. Işik[2]
([1]Forest Tree Seeds and Tree Breeding Research Directorate, [2]Akdeniz University - Turkey)
Estimated genetic parameters and gain for height from four years old *Pinus brutia* open pollinated progeny trials

O. Reyes and M. Casal
(Universidad de Santiago de Compostela - Spain)
Role of fire on seed dissemination and germination of *Pinus pinaster* and *P. radiata*

D. Sánchez-Gómez[2], F. Valladares[2] and M.A. Zavala[1]
([1]Universidad de Alcalá, [2]Centro de Ciencias Medioambientales, C.S.I.C. - Spain)
Differential survival to drought and shade of two pines and two oaks: linking leaf physiology to whole-plant performance

G. Schiller, L. Korol and G. Shklar
(A.R.O., the Volcani Center - Israel)
Within *Pinus halepensis* Mill. genetic variation as affected by microenvironments

S. Sengun S and H. Semerci
(Forest Tree Seeds and Tree Breeding Research Directorate - Turkey)
The effects of top pruning on flower and cone production in a turkish Red Pine (*Pinus brutia* Ten.) clone park established in Antalya, Turkey

I. Spanos[1], T. Zagas[2], Y. Raftoyannis[1], T. Tsitsoni[2] and P. Ganatsas[2]
([1]NAGREF, [2]Aristotle University of Thessaloniki - Greece)
Postfire natural regeneration of *Pinus brutia* in the forest park of Thessaloniki

R. Tapias[1], L. Gil[2] and J.A. Pardos[2]
([1]Universidad de Huelva, [2]Universidad Politécnica de Madrid - Spain)
Seed germination in Mediterranean pines

R. Tapias[1], L. Gil[2] and J.A. Pardos[2]
([1]Universidad de Huelva, [2]Universidad Politécnica de Madrid - Spain)
Life histories in Mediterranean pines

T. Tsitsoni, D. Karamanolis and G. Stamatellos
(Aristotle University of Thessaloniki - Greece)
Spatial distribution and connection of diameter classes in *Pinus halepensis* M. stands after wildfire

L. Valbuena, L. Calvo, S. Santalla, R. Tárrega and E. De Luis-Calabuig
(University of León - Spain)
Contribution of the seed bank to the regeneration of a community of *Pinus pinaster*

P. Villar-Salvador, S. Domínguez-Lerena and J.L. Peñuelas
(Centro Nacional de Mejora Forestal "El Serranillo" - Spain)
Preplanting water stress, planting depth and weed control affects the early performance of *Pinus halepensis* plantations

LIST OF PARTICIPANTS

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ABSTRACTS

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GERMINATION OF *PINUS NIGRA* SUBSP. *MAURETANICA* (ALGERIA)

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In Algeria, *Pinus nigra* subsp. *mauretanica* is an endemic species occurring naturally on the Djurdjura mountain (Algeria) where it is actually represented by approximately 450 individuals.
However, seeds germination tests of this pine, for three temperatures (18, 20 and 22°C) revealed high in vitro germinative capacity (with a germination rate of 90%) leading to an assumption that lack of *in situ* regeneration is not due to the physiological state of the seeds.
Key words: Algeria, *Pinus nigra*, seeds, germination, temperature, regeneration.

THE DISTRIBUTION OF *PINUS BRUTIA* TEN. (RED PINE) AND ITS MORPHOLOGICAL AND FLORISTIC STRUCTURE IN UPPER MENDERES RIVER BASIN (ÇIVRIL-DENIZLI)

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Pinus brutia Ten. is the widest spread pine species of the country with 3 million hectares total distribution area. It mostly spreads in the Mediterranean and Aegean Regions and is present as isolated groups in western, middle and coastal parts of the Black Sea Region. The eastern distribution point of the red pine extends till Denizli-Çivril region in upper Menderes River Basin. It is accompanied by different kinds of plant species that are varied in floristic structures that also characterize the Red Pine forest. Additionally, it shows varied morphological characteristics in Çivril region with its varied forms of structure. A part from these specialities, the monumental Red Pine trees with 1-2 meter diameter (bhc. level) are found in the region. So, because of its varied forms of morphological structure and monumental tree characteristics, the distribution and isolation of the *Pinus brutia* Ten. in Denizli-Çivril region should be accepted as genetic reserve and conservation area in term of biodiversity.
Key words: *Pinus brutia* Ten., floristic structure, morphological characteristics, the monumental Red Pine trees, genetic reserve and conservation, biodiversity.

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PINUS NIGRA ARN. SSP. *SALZMANNII* RELICT SPOTS IN SOUTH EAST SPAIN

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The collective species *Pinus nigra Arn*. is represented in Spain by the subspecies *salzmannii*, whose distribution is concentrated in three great mountain areas, located in the Iberian Peninsula's eastern half: Pyrenees, Iberian Mountains and Baetic Mountains. In the last mentioned area *Pinus nigra salzmannii* occurs in large extension masses - forests belonging to the Natural Park of "Sierras de Cazorla, Segura y Las Villas" should be highlighted - as well as in relict populations.
The objective of this paper is to locate relict populations of this species among which spots located in Sierra de Almijara (Málaga), Sierra Nevada and Sierra de Huétor-Quéntar (Granada) or Sierra de Lúcar and Filabres (Almería) should be highlighted. These populations are relegated to site factors limited (dolomitic soils, very hilly topography or very high areas) and have problems for its preservation due to previous site factors limitations as well as to its isolation, repeated fires and, in some cases, regeneration problems. Presence of these spots supports the thesis of *Pinus nigra*'s natural area regression, submitted by several authors and endorsed by historical, anthracological and pollinic evidences. Presence of these spots is also relevant to reconsider the role of this species in vegetal dynamic of Andalusian mountains.

INFLUENTIAL FACTORS ON NATURAL REGENERATION OF *PINUS NIGRA* ARN. SSP. *SALZMANNII* IN THE CAZORLA MOUNTAIN RANGE (SOUTH-EASTERN SPAIN)

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Achievement of natural regeneration of *Pinus nigra* Arn. ssp. *salzmannii* has been of great concern for Spanish managers from first forest planning of this species and particularly in masses located within the two south-eastern thirds of the Iberian Peninsula, occupied by the *hispanic* variety.

To clarify this topic, natural regeneration of the species has been investigated in the Navahonda mountain (belonging to the Natural Park of "Sierras de Cazorla, Segura y Las Villas", Jaén province) starting from a systematic sampling of 90 circular plots of 5 and 10 m radius. Site factors including soils, companion vegetation and light and management factors were measured.

After statistical processing of field data by means of SAS program, it can be concluded that suitable conditions to guarantee *Pinus nigra* Arn. ssp. *salzmannii* forests regeneration are: basal area between 20 and 30 m^2/ha; sand percentage bigger than 30%; maintenance of not lawned soils (*Brachypodium retusum, B. phoenicoides* and *Oryzopsis paradoxum*), and grazing control.

It's besides demonstrated that regeneration is more plentiful in areas of wood exploitation compared to Reservation Areas where only sanitary cuts are performed.

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GENETIC STRUCTURE OF *PINUS BRUTIA* STANDS EXPOSED TO WILD FIRES

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The genetic structure of brutia pine *(Pinus brutia* Ten.) stands exposed to wild fires, is reported. A systematic investigation identified areas of the species' distribution in Greece with frequent forest fires and located stands that had experienced ground fires about 20 years ago. These stands permitted sampling of the mature population that had survived the ground fire event ("mother" stand) as well as of the population of the regeneration ("progeny" stand). Electrophoresis was used in order to study isoenzyme variability in four such populations present in two localities (Kourteri, Lesvos island and Mytilineoi, Samos island). Results indicated absence of notable differences in the amounts of genetic diversity parameters among the remnant populations and the populations of the regeneration. However some differences were observed in the frequencies of rare alleles. Discussion focuses in the interpretation of the above results in the context of brutia pine evolutionary potential and maintenance of genetic variation.

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ECOLOGICAL INDICATORS OF POST-FIRE RESILIENCE IN *PINUS HALEPENSIS* FORESTS

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Fire is a major ecological factor in many biomes of the world. In the Mediterranean ecosystems fire has acted as an integral part of their evolutionary history, by having shaped their adapted traits. The specific regeneration behavior of plants is closely related to their physiological traits and is strongly influenced by fire regime (fire season, intensity, and interval). Post-fire 'succession' in the Mediterranean plant communities is an autosuccession that leads to the recovery of the pre-fire vegetation. Among the Mediterranean plant communities those consisted of *Pinus halepensis* Mill. forests are particularly important for several reasons. They are estimated to cover approximately $3x10^6$ ha in the Mediterranean Basin. In Greece, they constitute 8.72% of its forested area and they host high percentage of the plant species that are endemic in the fire prone habitats. Most of them are close to human settlements, thus recently experiencing quite frequent fires. The ability of predicting potential post-fire vegetation response and dynamics becomes crucial. In this contribution several ecological indicators are presented and evaluated for their reliability in predicting post-fire resilience of Aleppo pine forests.

STUDIES ON THE SELECTION OF SOME BEST GROWING CONIFEROUS TREE SPECIES IN THE SOUTHEASTERN ANATOLIA (RESULT IN 2000)

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The aim of this study is to determine the best adapted some coniferous forest tree species and provenances in terms of survival rate, height and diameter growth in South-eastern Anatolia. For this purpose 21 provenances of *Pinus brutia* Ten. (9 provenances), *Pinus halepensis* Mill. (4 provenances), *Pinus pinea* L. (4 provenances), *Pinus nigra* Arnold. (2 provenances), *Pinus eldarica* Medwed and *Cupressus sempervirens* var. *horizontalis* (Miller) Gordon. at Gölpınar (Şanlıurfa) and 15 provenances of *Pinus brutia* (8 provenances), *Pinus halepensis* (4 provenances), *Pinus pinea* (2 provenances) and *Pinus eldarica* at Düllükbaba (Gaziantep) sample plot were tried in a randomised complete block design with 3 replications and each replications were represented with 36 seedlings. The 1+0 year old seedlings in the polyethylene bags were planted at Gaziantep-Düllükbaba and Şanlıurfa-Gölpınar sample plots in March 1976. Periodical observations and measurements were made on these species and provenances.

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OVERVIEW ON THE AFFORESTATION ACTIVITY IN SICILY IN THE LAST 40 YEARS: RESULTS AND PERSPECTIVES

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In the last 40 years a very intensive afforestation activity has been carried out in Sicily. The main species employed have been *Eucalyptus* sp., *Cupressus* sp. and *Pinus* sp.. Within the genus *Pinus*, the Mediterranean species *P. halepensis*, *P. pinea* and *P. brutia* were the most widespread. In this study we analyse the growth features of these stands. The results confirm the good adaptability of *Pinus halepensis* to different environmental conditions. On the contrary, *Pinus pinea* requires a better soil quality. Good results in terms of biomass productivity were also obtained by *Pinus brutia*. The three species show certain ability to natural regeneration, especially *Pinus halepensi*s in the hardest environmental conditions (stony soils, quarries, burned areas).

ECOPHYSIOLOGY OF ECTOMYCORRHIZAL FUNGI ASSOCIATED WITH *PINUS* IN WESTERN AUSTRALIA

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Deep-rooted trees are being re-established in the low rainfall (<500 mm year^{-1}) region of Western Australia as a means of ameliorating rising water tables. As a means of monitoring tree establishment, aspects of the ecophysiology of ectomycorrhizal fungi associated with roots of plantations of *Pinus pinaster* and *P. radiata* were examined. A single species of mycorrhizal fungi, *Rhizopogon rubescens*, was found to predominate, with sporocarps and mycorrhizal-infected roots appearing with the onset of winter rains, increasing in number and biomass to peak in early spring and decreasing to negligible levels at the beginning of summer. Greatest numbers of active root tips were consistently located at depths of 10-20 cm despite the bulk of the soil organic matter being in the 0-10 cm layer. This suggests the overriding importance of soil moisture rather than nutrient status of the soil in determining root and fungal distribution. Seasonal patterns of enzyme activity of soil surrounding mycorrhizal roots (phosphomonoesterase, cellulase, *L*-asparaginase, *L*-glutaminase and □-glucosidase) are similar to those described for presence of mycorrhizal fungi. Information relating to factors responsible for patterns of seasonal activity and distribution of active ectomycorrhizal roots is essential for managing soils in order to maximise tree growth and form while effectively restoring soil water balance.

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VARIATIONS, SILVICULTURAL CHARACTERISTICS AND NATURAL REGENERATION OF *PINUS BRUTIA* TEN.

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Pinus brutia is a characteristic species of eastern Mediterranean. Its seedlings develop rapidly growing taproots. Fire is the major disturbance in *P. brutia* forests. It is a fire-adapted species and a number of adaptations generally contribute to its post-fire regeneration. However, *P. brutia* can naturally regenerate with and without fire. Flowering takes place between March and May. Seed distributions occur throughout the year with maximum dispersal in August, and the great majority of the seeds disperse within July-December period. It establishes natural canopy seed bank. Seeds germinate in the rainy season with two frequency peaks: the major one in spring and the minor one in autumn. The decision of natural regeneration method must be given after studying the site adequately. Shelterwood, clearcutting and strip clearcut methods could be applied to the *P. brutia* forests. Percent of *P. brutia* seedlings were higher and seedlings were more vigorous when the natural regeneration methods were combined with prescribed fire. Clearcutting methods combined with lying of cone bearing branches on the surface of the soil together with additional seeding increase the regeneration success. Ground litter of 2-4 cm creates a medium that reduces evapotranspiration, delays growth of competing vegetation and increases the percent of seedling survival. Success of the regeneration must be guaranteed at the end of first vegetation period.

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PHENOTYPIC PLASTICITY IN MEDITERRANEAN PINES (*PINUS PINASTER*, *PINUS HALEPENSIS* AND *PINUS NIGRA*)

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The role of phenotypic plasticity on the evolution of the species is not well understood. Some discussion exists on whether phenotypic plasticity is only a by-product of evolution or it can evolve by itself. According to the predictions of models of generalist vs. specialist species, genotypes that are more plastic should have a lower local fitness than those less plastic if the costs of plasticity play a role in evolution. However, the assumption of costs for the reaction norm is not supported by experimental data. This communication analyses the results of provenance trials of three Mediterranean pines (*Pinus pinaster*, *Pinus halepensis* and *Pinus nigra*), including provenances from the whole natural range of the species. The trials were established in Spain at five different locations for each species. An estimation of the genetic control of phenotypic plasticity at the provenance level is presented for survival, height growth, diameter, and polycyclism. Different levels of genetic variability and phenotypic plasticity were observed for the different species and traits, suggesting different evolutionary forces acting on these traits.

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HUFFEL'S "FÛTAIE CLAIRE": A SILVICULTURAL AND MANAGEMENT SYSTEM FOR STONE PINE (*PINUS PINEA* L.) WOODS

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The present concept of the forest as a complex biological system involves the definition of silvicultural and management systems able to follow the natural evolutionary processes of the forest, thus overcoming the theory of the normal forest.
The stone pine (*Pinus pinea* L.) stands of Alberese (Grosseto, Italy) have been studied according to this new approach. These pine stands are characterized by an "irregular" structure, significantly different from that of most Italian coastal pine stands, that are characterized by evenaged, monoplane structures, resulting from management based on clear cutting and artificial regeneration.
This paper proposes new silvicultural and management criteria for stone pine stands, developed according to the bioecological characters of the species and on the basis of its growth dynamics, derived from dendrocronological techniques.
The proposed treatment refers to Huffel's "*fûtaie claire*" system, properly modified to be applied in the Mediterranean environment. This system maintains ground cover, avoids shocks to the ecosystem and favours stone pine natural regeneration.

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VARIATION OF NEEDLE ANATOMY IN *PINUS CANARIENSIS*

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Cross-sections of secondary needles were analysed in adult *Pinus canariensis* Chr. Sm. One needle per tree of five individuals per stand was studied to gain insight into possible geographical and climatic trends of variation in needle anatomy. Seventeen natural populations at the Canary Archipelago plus two plantations were sampled. The cross-areas of the different needle tissues (epidermis + hypodermis, mesophyll, resin ducts, vascular bundles and stella) were obtained through image analysis, as well as the perimeter of the inner hypodermis-mesophyll boundary (HDP). Significant linear relationships were found among most variables. Univariate analyses, through Anova-Ancova were applied, with needle cross-area as a covariate. Two different models were used, a nested model with Island and Population within Island and an alternative model with climate type (a categorical classification based on vegetation types) as a single factor. Significant differences among islands were found for most traits, while population was significant only for HDP and vascular bundle area. Climatic differences were present in HDP and area of the vascular bundle, which was lower in dry stands and increased in milder conditions. Despite these differences, the variation in needle anatomy in natural stands of *Pinus canariensis* was lower than expected, considering the extreme climatic differences among provenances. However, the outlier behaviour of the two plantations may be reflecting a genotype x environment interaction.

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LIFE HISTORY OF CANARY ISLAND PINE (*PINUS CANARIENSIS* CHR. SM.) IN ITS NATURAL RANGE OF DISTRIBUTION

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Pinus canariensis Chr. Sm., endemic to the Canary Archipelago, displays several traits that underline its singularity amongst the Mediterranean pines. Moreover, recent DNA studies revealed the genetic proximity between this species and *P. pinaster*, *P. halepensis* and *P. pinea*. Cone morphology is extremely variable within and between populations and shows similarities with the mentioned Mediterranean pines. The natural range of distribution of *P. canariensis* includes basal sub-desserts with less than 250 mm of rain per year, sub-tropical wet cloud forests with more than 800 mm per year (plus high throughfall due to mist-capture), and high mountain stands with winter frosts and snow. Fire adaptation is striking. A tall, straight growth habit, thick bark (>10 cm) and epicormic sprouting make old trees highly fire resilient. In addition, juvenile basal resprouting and efficient after-fire recruitment from serotinous cones ensure multi-aged stand survival. Cone serotiny is a widespread trait, still little studied in this species. Highly resinous heartwood is present in most trees older than 100 years and in younger fast-growing trees. Durable heartwood is related to the fire-resilient strategy, preventing tall trees from heart rotting. Long needles (20-30 cm) accumulated in thick dry layers (>30 cm) impede the installation of a dense underwood in typical dry pine stands and facilitates the occurrence of ground fires.

POSTFIRE REGENERATION OF ALEPPO PINE – TEMPORAL PATTERNS OF SEEDLING EMERGENCE

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The postfire emergence, density and survival of *Pinus halepensis* seedlings were studied in five Aleppo pine forests of Attica (Stamata, Villia, Avlona, Kapandriti and Ag. Stefanos; burned in June 1990, July 1990, September 1991, September 1992 and July 1993, respectively). The timing of emergence and establishment of Aleppo pine seedlings was found to be correlated with the meteorological conditions (mainly rainfall and to a lesser degree temperature). In most cases seed germination and seedling emergence took place in a 'single massive wave' (resembling a right-skewed normal distribution), shortly after the onset of the first postfire rainy season, (Stamata, Villia and Avlona; 80-90% of the total cohort emerged during November-December). However, variations in the timing and spread of this pattern were obtained in Agios Stefanos and Kapandriti. In the former, there was a considerable delay of seedling emergence (86% by the end of February); in the latter, a bimodal pattern was found (peaks in December-February and March-April). Pine seedling mortality (30-60% of the cohort) showed two major peaks during the first postfire year: in winter, at the initial phase of seedling establishment, and during the dry summer.

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GROWTH DYNAMIC OF *PINUS HALEPENSIS* IN A RAINFALL GRADIENT OF THE REGION OF VALENCIA (SPAIN)

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In Eastern Spain, in recent years a clear decline has been observed in more pine populations located in semiarid conditions. In these conditions, water availability represents the most limiting factor in forest development but there exists little information about relation between tree growth and climate variables. The data used in this study come from 4 Aleppo pine populations of Valencia region that represent a rainfall gradient from semiarid to subhumid conditions. In each location, radial growth and presence of missing rings has been measured in 15 pines using 2-4 cores per tree. Obtained chronologies cover from 1880 to 2000 and represent the longer dendroecological series of coastal Mediterranean Spain. Results obtained show that precipitation plays a much more important role for *Pinus halepensis* growth than temperature. However, an important variability has been found in different rainfall areas. Presence of missing rings is highly related with rainfall regime, too. In semiarid areas, forest decline seems confirmed but climate variability seems that it was not the only cause of it. Management forest policies, changes on patterns of conservation and new trends on rural tourism are elements that could account for the decline.

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NURSERY AND FIELD GROWTH OF *P. HALEPENSIS* SEEDLINGS FERTILISED IN THE NURSERY WITH DIFFERENT AMOUNTS OF N, P AND K

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The objective of this study is to seek for nitrogen, phosphorus and potassium fertilisation, which maximises the quality and the outplanting performance of *Pinus halepensis* seedlings. A factorial experiment combining three levels of N fertilisation (N_3=114 mg plant^{-1}, N_2=57 mg plant^{-1}, N_1=34 mg plant^{-1}), and two P (P_2=47,5 and P_1=23.7 mg plant^{-1}) and K levels (K_2=95 and K_1=47.5 mg plant^{-1}) was made. N_3 enhanced shoot growth (12%), tissue N concentration (15%) and new root growth capacity (RGC), whereas P_2 and K_2 only increased the tissue concentration of these nutrients (11% and 31%, respectively). In some fertilisation combinations, K_2 caused toxicity. Thus a significant interaction between N and K fertilisation on RGC was observed, the N_2K_2 and N_3K_2 combinations showing a lower RGC than N_2 K_1 and N_3 K_1 whereas no differences existing between the N_1 K_2 and N_1K_2 combination. A significant interaction between N and P fertilisation on the field growth was observed. All N treatment exhibited a higher growth when fertilised with P_2 than P_1, but growth increase was higher in N_1 plants than in the N_2 and N_3 ones. No survival differences were observed among fertilisation treatments. The highest growth was observed in the seedlings fertilised with the $N_1P_2K_2$, $N_1P_2K_1$ and $N_3P_2K_1$ combinations.

CAN THE CONTAINER TYPE INFLUENCE THE OUTPLANTING PERFORMANCE OF *PINUS HALEPENSIS* AND *PINUS PINEA* SEEDLINGS?

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P. halepensis and *P. pinea* seedlings were cultivated for one year in 16 different containers, which volume, cultivation density and height ranges from 120 to 400 ml, 170 to 800 plants/m^2 and 10 to 23 cm, respectively. The objective of this study has been the analysis of container characteristics on the plant quality and field performance of *Pinus halepensis* and *Pinus pinea*. In both species, significant relations between the container volume and the density in the nursery have been observed. Plants grown in larger container showed a higher N, P and K assimilation efficiency (AE), were larger and had a higher nutrient content than those reared in smaller containers. Seedlings cultivated at a higher density presented a lower P and K AE, were smaller and presented a lower nutrient content. Plant features in the nursery were not related with container height. Although the studied containers had anti-spiralling ribs, all produced some plants with coiled roots. The angle of coiling roots was more pronounced in *Pinus pinea*, but *Pinus halepensis* exhibited a higher number of twisted roots. Only *P. pinea* had significant and relations between the volume and the density of the containers with the plant field performance development in the field. Thus, seedlings grown in larger containers (r^2=0.6) and at a lower density (r^2=0.4) showed a higher growth three years after planting. In both species, we found significant and positive relations between container height and field growth and survival.

NURSERY AND FIELD GROWTH OF *P. PINEA* SEEDLINGS FERTILISED IN THE NURSERY WITH DIFFERENT AMOUNTS OF N, P AND K

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The objective is to seek for the nitrogen, phosphorus and potassium fertilisation, which maximises the quality and the outplanting performance of *Pinus pinea* seedlings. A factorial experiment combining three levels of N fertilisation (N_3=77,7 mg plant^{-1}, N_2=43,2 mg plant^{-1} , N_1=5,8 mg plant^{-1}), and two P (P_2=20,2 and P_1=2,9 mg plant^{-1}) and K levels (K_2=43,2 and K_1=8,6 mg plant^{-1}) was made. N_3 enhanced shoot mass (10%) and tissue N concentration (22%). P_2 increased shoot (5%) and root (7%) growth, and tissue P concentration (10%). New root growth capacity was influenced by an N and P interaction. The N_2P_1 and N_3P_1 combinations produced 50% less new roots than N_2P_2 and N_3P_2 no differences existing between N_1P_1 and N_1P_2 combinations. K_2 increased 11% the tissue concentration of this nutrient. Field growth was influenced by N-K and N-P interactions. N_1K_2 and N_2K_2 fertilised plants grew a 20% less than the N_2K_1 N_2K_1 combinations, no differences existing among the N_3K_2 and N_3K_1 ones. Similarly, N_2P_2 and N_3P_2 combinations showed a 20% diameter increase with respect to the N_2P_1 and N_3P_1 whereas N_1P_2 showed a growth reduction with respect to N_1P_1. No differences in survival were observed among treatments. The best field performances were in those seedlings fertilised with $N_3P_2K_2$, $N_3P_2K_1$ and $N_2P_2K_1$.

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THE MECHANISM OF CONE OPENING IN *PINUS HALEPENSIS* AND *P. BRUTIA* – MORPHOLOGY AND PHYSIOLOGY

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After a wildfire, a massive seed release and dispersal is manifested by the two major Mediterranean pines, *Pinus halepensis* and *P. brutia*. Both species build a canopy seed bank by retaining closed (serotinous) a significant percentage of their annual cone production. This results in a considerable delay (sometimes up to several decades long) of cone opening and therefore seed dispersal (bradychory).
The mechanism of cone opening in these pines is the combined outcome of two successive but distinct events: a) the initial 'unsealing' of the cone scales due to the heat of either solar radiation or fire, which melts the resin of the sealing band at the apophysis edge of each cone scale, making them to separate slightly and b) the subsequent cone opening due to the moisture loss from the slightly separated scales which leads to a differential, lengthwise shrinkage of their two tissue systems (outer/abaxial sclerenchyma - inner/adaxial tracheids). In dry conditions (and similarly to a bimetallic element) the scales bend away from the central cone axis (xerochasy), thus allowing the release of pine seeds; under moist or wet conditions the scales bend back and close the cone.
The 'unsealing' of the scales is the particular trait that establishes pine serotiny; certain aspects of this adaptation are investigated and discussed in the present study.

THE EFFECTS OF THINNING IN SEEDLINGS OF POST-FIRE *PINUS PINASTER* AIT. REGENERATION ON CARBOHYDRATE STORAGE CONTENTS

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A study is being conducted on the effect of silvicultural treatments on non structural carbohydrate (TNC) dynamics, by measuring sugar and starch concentrations of needles and roots in *Pinus pinaster* Ait. seedlings, originated by post-fire regeneration in an area burned in 1994 in Galicia (NW of Spain). Three types of treatment with 5 replicates of each: no thinned, 78% and 94% initial stocking removed. Seasonal patterns of sugar and starch concentrations showed in both, leaves and fine roots, a trend to be inversely related. Compared with roots, needles generally contained the highest concentration of carbohydrates in the sugar form and exhibited the major seasonal change in carbohydrate concentration. The effects of thinning generally seemed to enhance the carbohydrate concentrations. Both treatments resulted in a higher concentration of carbohydrates in both, leaves and roots, compared to control. Roots TNC concentrations appeared to be highly variable among treatments and no significant differences were observed.

The preceding results are in accordance with those of other study in the same area, suggesting that TNC can act as a growth bioindicator.

RECOLONIZATION OF A *PINUS PINASTER* STAND BY CARABID BEETLES AFTER A WILD FIRE

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The aim of this study was to determine changes in Carabidofauna after a wild fire in June 1996 in a *Pinus pinaster* forest, Zamora province (Spain). Sampling was carried out from April to October 1997 in the burnt area and in a nearby unburned (control) pine forest. Pitfall traps were placed in each area at different distances from the firebreak. The colonizing species in the burnt area are described and compared to those captured in the control pine forest. Data on abundance, specific richness, equitability and diversity are given and, structural changes and the composition of the Carabidae community after the fire are also discussed. Results indicated that greater abundance, diversity and specific richness were observed in the burnt pine forest due to the arrival of opportunist species after the wild fire. Species adapted to open areas were captured in the burnt pine zone whereas species detected in the control one are characteristically located in areas covered by a lot of vegetation or in grasslands, needing more humidity and are therefore not tolerant to prevailing post-fire drought conditions.

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RESULTS OF *PINUS ELDARICA* INTRODUCTION TESTS IN ITALY AND MANAGEMENT PROBLEMS OF MEDITERRANEAN CONIFER EXPERIMENTAL PLANTATIONS

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Pinus eldarica Medwed is a variety of *Pinus brutia* Ten. It was introduced in Italy within the framework of the project FAO/SCM/CRM/4 bis which started in 1975 and dealt with research on primary sources of pines belonging to the *halepensis* Section. Since 1980 many small plantations (1-2 ha) of *P. eldarica* have been established in different parts of South and Central Italy, including the islands of Sardinia and Sicily, within afforestation programmes. This report presents the results obtained from a few significant adult or mature plantations. Most of the material used came from Transcaucasia and two primary sources from Iran. The results also demonstrated that *P. eldarica* can be utilised in Mediterranean areas, particularly where it is difficult to plant more demanding species. *P. eldarica* can also be established for commercial plantations as well as to face new environmental emergencies such as the struggle against erosion and desert zones, restoration of quarries and dump areas, biomass production, etc. The following problems have also been discussed in this report:

- the management and maintenance *ex situ* of genetic resources introduced from other countries in order to avoid genetic pollution of local populations;
- reserve banks of seed and other propagating material for production in nursery;
- involve local organisations to finance the maintenance costs of plantations such as cultivation techniques, protection from fire and disease and pest control.

RESTORATION OF DEGRADED ECOSYSTEMS IN THE ASSOCIATION OF COCCIFERETUM USING MEDITERRANEAN CONIFERS

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The ecosystems of Ostryo-carpinion occupy wide area in Greece and they are characterized by heavy degradation due to long time human activities. The restoration of these ecosystems can be carried out either by natural methods or by artificial interventions. This paper examines the results of plantations of mediterranean conifers (*Pinus halepensis, P. pinea, Cedrus libanii* and *Cupressus arizonica*) in the hilly area of Vasilika, North Greece. Plantations were carried out in randomized blocks using two years old paper-pot seedlings. Data were taken from three permanent plots established for each species located in three different positions. A number of 90 seedlings per species (30 seedlings in each plot) was measured five years after the plantations. Field data analysis showed that *Pinus halepensis* exhibited the highest survival and growth rate comparing to the other three species. All species presented quite high survival rates and medium to high growth rate. The very extreme low temperatures appeared during the winter of the year 2001-2002 slightly affected species survival. The above results show that these mediterranean conifers can be used with success in restoration projects of degraded areas in the association of Cocciferetum in Greece.

RELATIONSHIP BETWEEN NAO TELECONNECTION PATTERN AND *P. HALEPENSIS* GROWTH IN WESTERN MEDITERRANEAN BASIN

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North Atlantic Oscillation (NAO) is the most prominent teleconnection pattern, and source of interannual variability in atmospheric circulation and climatic conditions in mid latitudes of N.H. In western Mediterranean basin (Valencia Region, E of Spain) previous studies indicated a significant correlation between NAO index and rainfall in inland areas, and no relationship in coastland areas, both at annual and seasonal scale. We investigated the relationship between *P. halepensis* growth and NAO index from 1950 to 1999 in two sites, one of them located in coastland and the second one in inland area. The results are discussed considering the spatial distribution of NAO pattern and their control on rainfall at annual, seasonal and monthly scale.

SEED ESTABLISHMENT OF *PINUS PINEA* AND *PINUS HALEPENSIS* IN A SEMIARID SAND DUNE ECOSYSTEM OF SPAIN

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In Western Mediterranean areas, pine forests became from afforestations undertaken during 1910-1930. In recent years on semiarid areas a forest decline has been detected on two levels: increased adult mortality and absence of recruitment. Seedling survivorship and establishment are considered the most important factor controlling species distribution under Mediterranean conditions. In the case of semiarid climates, the combination of water scarcity, high levels of radiation, and increasing impact of recreation activities restricts severely plant regeneration processes. The study area is located in the southeast coast of Spain, on Guardamar del Segura (Valencian Region), a sand dune *P. halepensis* and *P. pinea* afforestation. In this place we evaluate germination capacity and establishment of these species in different soil conditions that mimic different degree of disturbance. In general, these two species showed different germination behaviour (43% for *P. halepensis* and 83% for *P. pinea*). The best recruitment for both species was obtained on disturbed treatments. After sixteen months, all seedlings of *P. halepensis* were dead whereas *P. pinea* showed a 40% survivorship. On this last species, the best survivorship was found under altered conditions. The mortality rate increased in summer due both to rainfall scarcity and elevated temperature. Another factor of mortality on the areas was camping and underfoot.

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THEOPHRASTUS ON PINES

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Theophrastus of Eressus (371-286 BC), the founder of Botany and the co-founder (together with Aristotle) of Biology, has amply described, referred and commented on pines in his extant botanical works (*ΠΕΡΙ ΦΥΤΩΝ ΙΣΤΟΡΙΑΣ* - *ENQUIRY INTO PLANTS* ***HP****, ΠΕΡΙ ΦΥΤΩΝ ΑΙΤΙΩΝ* - *CAUSES OF PLANTS* ***CP***).

Although not a taxonomist in the strict sense, Theophrastus recognized and described at least 3 different 'types' of pine: (i) the coastal and low-altitude pine (πίτυς) – *Pinus halepensis* and *P. brutia*, (ii) the mountain pine or pine of Ida (πεύκη, Ιδαία πεύκη) – *Pinus nigra* and (iii) the 'domestic' or 'cone-producing' pine (πεύκη η ήμερος, πίτυς η κωνοφόρος) – *Pinus pinea*.

In over 100 direct citations on pines, Theophrastus deals with a large variety of subjects, such as general morphology (foliage, bark, reproductive organs), vegetative growth (slow rate, polycyclism, importance of shoot apex), root habit (deep and unbranched), regeneration (propagation only through seeds and not vegetatively, early cone production), ecological characteristics (heliophilous habit), seed composition (oily taste) and useful pine products (resin, pitch, torch-wood, charcoal, timber for ship- and house-building).

COMPARISON OF RAPID VARIATION BETWEEN *PINUS BRUTIA* TEN. SEED STANDS AND PLANTATIONS FROM TURKEY

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Random amplified polymorphic DNA (RAPD) markers were used to determine and compare the genetic diversity and changes in amount and pattern of genetic diversity in *P. brutia* (Turkish red pine) seed stands from 6 tree breeding zones (indicated in National Tree Breeding and Seed Production Program for Turkey, 1994-2003) and plantations originated from these stands. 25 parent trees were sampled from each seed source. Twelve decamer primers generated 86 polymorphic RAPD bands. Mean number of effective alleles did not differ significantly between seed stands (*Ne*=1.48) and plantations (*Ne*=1.46). Gene diversity maintained within plantations (Ho=0.25) was identical to the source area (seed stands) for Turkish red pine (Ho=0.24). Proportion of polymorphic loci (% P) was 76% and 75% for seed stands and plantations, respectively. Slight decrease in % P of three plantations could be attributed to nursery practices. Genetic diversity that resides in seed stands was successfully captured in plantations. It seems that seeds for these plantations come from enough numbers of seed trees, which is sufficient to preserve their genetic base in seed stands. Plantations (F_{IS}= 0.07) showed reduced locality inbreeding coefficient compared with seed stands (F_{IS}=0.13), due to the sampling of possibly unrelated families.

STRUCTURAL ANALYSIS OF THE CALABRIAN PINE FORESTS IN SILA MOUNTAINS (SOUTHERN ITALY)

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The forest landscape in large areas of the Sila in Calabria is characterized by black pine groves. Here the largest and most interesting forests extend over 40,000 hectares at altitudes ranging from 900 to 1600 meters above sea level. The climate is typically Mediterranean, the ground is characterized by the association of Typic Xerumbrepts in areas marked by less erosion and Lithic and Dystrict Xerorthents in areas where erosion is greater. In the past management of the Sila pine groves was characterized by progressive or alternating clear cutting along small strips (15-20 x 40-50 m), clear cutting on small areas (300-400 m^2) and in private forests by selection felling, eliminating plants with diameters of 50-60 cm. In this paper the authors present an analytical description of the three different structures that result from the various methods of treating the stands: pure pine groves, pine groves with abundant, widespread young broadleaved trees, and black pines that dominate adolescent and young beech forests. They highlight the factors that cause the changeover from one structural type to the other and specify the management methods for conserving the groves that are a distinctive feature of the forest landscape in this part of the Calabrian mountains.

CLONAL VARIATION OF FLOWER PRODUCTION IN A *PINUS BRUTIA* SEED ORCHARD

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The numbers of female and male strobili (flowers) were assessed on 28 clones (10 ramets per clone), for three consecutive years (1996, 97, 98) in a *Pinus brutia* seed orchard, established in 1986 near Antalya. There were statistically significant differences among the clones, and among the years in the production of both female and male strobili. Clone x Year interaction was highly significant for female, but weakly so for male flowers. On average of three-year period, the top seven (first quartile) of the clones produced 34% and 57% of the total female and male strobili, respectively. The overall mean number of female strobili per ramet was 186, and of male was 2176. Pearson's product moment and Spearman's rank correlation coefficients between years for male flower production were positive and highly significant for all combination of years. Corresponding relationships for female flower production were also positive, but not significant except that between 96-97 observation years. Kruskal-Wallis test showed that clones were significantly consistent in their ranks over the observation years in male flower production, but not in female flower production. Broad sense heritability based on an individual ramet basis was 0.34 for male strobilus, and 0.18 for female strobilus.

ENVIRONMENT-FRIENDLY CONSTRUCTION OF FOREST ROADS IN *PINUS BRUTIA* FORESTS

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The most recent development in the construction of forest roads is the environment-friendly construction. Here, the result is not affected only by the construction or economic parameters but mainly is studied the effect, direct and indirect of the new constructions upon the natural but also on the normal environment. The prons and cons are weighed down and an effort is made for setting out an optimum solution.
In the paper two alternative solutions of a road opening-up in *Pinus brutia* forests are proposed and within the frames of an environment-friendly construction are tracked down and estimated as much as the quantitative as well as the qualitative effects. In order to classify their hierarchy these alternatives are compared. Furthermore, an investigation is done of how much the result of hierarchy is affected by the environmental impacts.
Keywords: Environment-friendly road opening-up, comparison of alternative solutions, estimation of impacts.

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LONG-TERM POST-FIRE VEGETATION DYNAMICS IN *PINUS HALEPENSIS* FORESTS OF CENTRAL GREECE: A FUNCTIONAL -GROUP APPROACH

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Long-term post-fire vegetation dynamics of Aleppo pine forests was studied with the use of permanent plots at twenty-one communities of different post-fire age. The overall pattern was found to be more consistent to the "initial floristic" pattern reported already for Mediterranean shrublands. Consequently, differences in the initial structure of the pine forest revealed differences in the post-fire vegetation dynamics pattern. In order to explain those differences and reveal the mechanisms that determine the various patterns, a functional group analysis of the plant community was introduced. The attributes of the species that were taken into account for this classification were related to the species growth form (tree, tall shrub, low shrub, liana, herb), their regeneration mode (resprouters, seeders), their means of persistence (long life span, secondary seedling establishment, resprouting) and, finally, in particular for the herbaceous species, any extra advantageous feature that characterizes some species (nitrogen fixation, rapid vegetative growth, subterranean storage organs). Combinations of the above species attributes resulted in 26 groups of species, the application of which permitted the description and determination of the different phases of the post-fire vegetation dynamics. Furthermore, the potential use of some of the groups as indicators of fire resilience in these communities is discussed.

VARIATION IN CONE AND SEED CHARACTERISTICS OF *PINUS PINASTER* A. IN ALGERIA

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Pinus pinaster cone and seed characteristics were studied in two close stands located in the northeastern part of Algeria (El-Kala) and differing in density and exposition.

If we except *in vitro* germination rates which showed a greater difference between stands (i.e. 82% in the more opened stand and 45% in the more covered one) than between trees in a stand; the other studied parameters showed a greater variation between trees of the same stand than between stands. Correlation matrix revealed a positive relationship between cone dimensions (i.e. length and diameter) and weight, and also between cone dimensions and seed weight, while seed germination did not show a significant correlation with cone dimensions and weight.

The good *in vitro* germination rates are in relation with a good dynamic of field recruitment. In fact, the species is in competition with the cork oak which, in contrast, is suffering from a difficult natural recruitment.

These results are obtained from a single reproductive year and may be completed by other observations, in order to have a better understanding of the recruitment dynamic and biocenotic interactions.

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A SURVEY ON THE EFFECT OF FIRE ON THE BEHAVIOUR OF AUTOCHTHONOUS PINES IN SICILY, WITH SPECIAL REFERENCE TO THE RE-COLONISATION PROCESSES PERFORMED BY MEDITERRANEAN SPECIES

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Sicily is very frequently affected by wildfires. After land abandonment phenomena, which occurred in many parts its territory after the Second World War, an intensification of grazing has been recorded. The effect of wildfires, added to overgrazing, cuttings, etc., increased the floristic and the structural discontinuity and heterogeneity of the pre-forest relic formations, enhancing the widespread of xeric prairies and shrubland disclimax, rich in sub-nitrophilous and semi-ruderal taxa.
Wildfires affect prevalently the infra-, thermo- e meso-mediterranean bioclimatic belts, where most part of human settlements and activities are concentrated; at the more elevated belts, the impact of wildfires is less important, in terms of frequency and surface. The present contribution aims at providing a preliminary survey of the main dynamic steps of forest vegetation after fire disturbance, through some examples concerning the most affected bioclimatic belt. Besides, the present investigation puts into evidence the connections between the cover rate and the re-colonisation processes. Some peculiar case studies are reported to focus fire effects on the different strategies adopted by some Mediterranean conifers (*Pinus halepensis* and *P. pinea*), widely employed in the past for artificial plantations.

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CONSERVATION OF MEDITERRANEAN PINE WOODLANDS

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With at least 111 species, genus *Pinus* covers the northern hemisphere with a large distribution from near the Arctic to the tropics, i.e. in a range from 10 to 70 ° Lat. N. Pines always traditionally provided so wide a range of products and environmental effects, that considering *Pinus* the most ecologically and economically significant genus can be accepted and shared. Given the multiplicity of products, human activities over the past thousand years have strongly interacted with distribution of pine forest; in many cases, harvesting was made in terms of destructive logging. Just recently people have come to recognise the value of wood in general and of course also of pine ecosystems but often when the original forests were already disappeared. This late reconnaissance demands to cope with the human induced impacts still active on pine forests: changes in fire regime, in grazing/browsing intensity, in harvesting, in land use, in plantation activity, in expansion of forest/urban interface, in secondary urban settlements. Conservation in this context means the maintenance, the restoration or improvement of the abiotic and biotic features, which form the habitat of a species, the control of activities, which may indirectly, result in the deterioration of such habitats. Conservation therefore ranges from conservation of genetic resources (seed banks, seed forests, conservation in situ of relic populations..), to elimination of human induced disturbances, planning of new activities, application of proper silvicultural tending and pursuance of International Conventions, Regulations and Resolutions.

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POST FIRE REHABILITATION OF *PINUS HALEPENSIS* MILL. STANDS AND THEIR TREATMENTS: A CASE STUDY

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Post fire rehabilitation of low elevation Mediterranean conifers, such as *Pinus halepensis,* is rather a neglected topic and literature gives only few guidelines about treatments to be carried out after passage of fire. During the first phase of treatments after fire, in species with serotinous pines, such as *Pinus halepensis*, exhibiting seed bank in the crown, standing dead trees can help to reduce extreme site conditions: their cutting must therefore be possibly delayed until regeneration assures satisfactory rates. Given the crucial role of seedlings for the re-establishment of the original canopy cover, logging operations in burnt areas should not be carried out before two years after fire. When regeneration is well established and has reached a satisfactory rate, the first treatment to be carried out is thinning; for this phase, literature is rather poor and only few researchers did cope with this problem. In this paper we present the results of our research, carried out in an artificial plantation of *P. halepensis*, aged 38 years, growing on calcareous bedrock and swept by fire in 1993. We follow since 1998 post fire treatments and their results on about 30 hectares of surface, confirming that delayed post fire treatments are very positive. Treatments carried out in the same year (autumn) and treatments carried out 16 months after fire, actually give very significant differences in terms of seedling, dbh and height. These results are very interesting, since they were carried out by official Agencies on huge surfaces and not in small plots, following routine protocols. For thinning we have early results of four different treatments; collective thinning favours excellent shape and growth of the inner leader tree.

IN-SITU AND *EX-SITU* CONSERVATION OF AN OLD NATURAL STAND OF *PINUS HALEPENSIS* IN "HA'MASREK" RESERVE IN ISRAEL

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The old stand of *Pinus halepensis* Mill. in the "Ha'Masrek" reserve is one of several isolated natural stands in Israel, believed to be relicts of the original local population that has a unique genetic divergence. "Ha'Masrek" is the oldest population in Israel, preserved because of a holy Moslem tomb located there. Tree-ring analysis showed a clear radial growth decline in the last several decades, unique for each old tree. The main aim of the project is to conserve (*in-situ* and *ex-situ*) the genetic identity of the stand. We will characterize the genetic structure of the population using RAPD's and compare it to other natural populations in Israel and elsewhere. It will provide the information needed for the management of the reserve. Reconstruction of the original genetic structure will be achieved by planting rooted cuttings from the old original trees and elimination of recently introduced genotypes.

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THE HYDRAULIC ARCHITECTURE OF PINACEAE

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The vulnerability to xylem embolism limits gas exchange and, in many cases, the ability of plants to cope with drought stress. Despite being able to live in arid environments, pines (genus *Pinus*) are characterized by high vulnerability to drought-induced xylem embolism compared to other conifers, and show very little variation among populations or species in this vulnerability. Although the reasons for this are still not clear, it should have important implications for water relations. We used data from 12 pine populations (11 species of genera *Pinus*, *Abies*, *Larix* and *Pseudotsuga*) from three different locations (two of them in the Mediterranean basin) to test general hypotheses regarding the relationships among hydraulic parameters. Our results showed that foliar C isotopic composition changed ($\delta^{13}C$ increased) as minimum leaf water potentials decreased, suggesting higher WUE and stomatal control in more water stressed sites. In contrast, other plant parameters (hydraulic conductivity, vulnerability to xylem embolism, A_l:A_s) were uncorrelated with minimum water potential. In spite of the low variability in vulnerability to xylem embolism, the pressure causing 50% loss of hydraulic conductivity was positively correlated with $\delta^{13}C$. This result is consistent with our hypothesis that more vulnerable trees need a stricter stomatal control. The reliance on physiological rather than xylem structural plasticity may compromise the ability of pines to cope with increased aridity caused by climate change.

FOREST DYNAMICS IN CLUSTER PINE (*PINUS PINASTER* AIT.) STANDS IN TUSCANY (CENTRAL ITALY)

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The study area was located in a hilly region in Tuscany (Central Italy). The native mixed broadleaved coenoses, dominated by Turkey oak, Sessile oak and Chestnut, were replaced by a sub-atlantic shrubland (*Tuberario lignosae-Callunetum* De Dominicis and Casini, 1979) as a consequence of grazing and intensive coppicing. At the end of the XIXth century Cluster pine (*Pinus pinaster* Ait.) was introduced by seeding to improve the productivity of these shrublands. From the '40s these Cluster pine stands have burned periodically (20-30 years). In this area no silvicultural treatment was regularly applied. On the basis of the stand structure analysis, from the establishment up to 40-50 years, five different phases were recognised: I) 1-5th year, high density natural regeneration establishment immediately after fire; II) 5-10th year, development and early social differentiation; III) 10-30th year, high selection and density reduction, stop of the growth in co-dominant, dominated and suppressed trees, low functionality of biological processes, groups of slender trees frequently bent under snow precipitations, high mortality; IV) 30-50th year, progressive gap opening, heavy biomass accumulation as a consequence of a high number of dead trees; V) fire, total or partial stand destruction. Criteria of forest management for each stand structure are suggested.

FOREST TYPES IN CALABRIAN PINE (*PINUS LARICIO* POIRET) STANDS IN THE ASPROMONTE NATIONAL PARK

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Calabrian pine (*Pinus laricio* Poiret = *Pinus nigra* Poiret ssp. *calabrica* Delam.) characterises the mountain scenery of the Aspromonte National Park (Southern Apennine, Italy) and represents an interesting species also from silvicultural, genetical and phytogeographical point of view. Calabrian pine stands prevail in the southern slopes between 1200 and 1600 m, more infrequent in the western slopes between (900) 1100 and 1350 m. They cover an area of about 3000 hectares most of them (2000) pure. A research on Calabrian pine stands to define ecological requirements, natural distribution and phytosociological and forest types classification was carried out.
In consequence of these investigations new forest types have been distinguished:
-Pure pinewoods of Calabrian pine, referred to the *Hypochoerido-Pinetum calabricae*
-Pinewoods of Calabrian pine with Sessile oak, attributed to the *Hypochoerido-Pinetum calabricae* facies with *Quercus petraea* ssp. *austrotyrrhenica*
-Pinewoods of Calabrian pine with Beech, referred to the *Hypochoerido-Pinetum calabricae* facies with *Fagus sylvatica.*
For each forest type appropriate silvicultural practices of low environmental impact are suggested.

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SPATIOTEMPORAL DYNAMICS OF RECRUITMENT IN ALEPPO PINE

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Seed dispersal and seedling establishment are key processes in the dynamics of forest trees, hence are critically important for the management of natural and planted forests. These processes were investigated by integrating modeling, laboratory and field work in two *P. halepensis* stands in Israel. Considerable seed release – estimated as 60% of the annual crop – was observed in the absence of fire, correlated with dry and hot weather events characterized by relatively strong wind updrafts, suggesting adaptive value of serotiny in promoting dispersal distance by wind. A new mechanistic model, which incorporates full stochasticity in wind conditions, seed terminal velocity and release height, proved reliable in predicting seed dispersal to traps in a resolution of 1 m^2. Estimated dispersal curves were right-skewed and leptokurtic. Sensitivity analysis showed that the effects of winds on the dispersal distance override those of the biotic factors. Saplings were located mostly within 15 m from the nearest canopy, rarely farther away, and never under the canopies. The estimated seed-to-sapling survival probability significantly increased with distance from adults, as predicted by the escape hypothesis. Spatial analyses revealed inter-seasonal consistency in seed deposition patterns for the area near adult trees, but considerable variation farther away. It is suggested that this pattern acts to intensify the effects of predation and competition in structuring the survivorship curve predicted by the escape hypothesis.

REPRODUCTIVE TRAITS OF *PINUS HALEPENSIS* IN THE LIGHT OF FIRE

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Pinus halepensis is known as a post-fire obligate seeder species. Many of its reproductive traits are advantageous in the post-fire regeneration environment. Early reproductive maturation (5 y), producing female cones before males with a high percentage of serotiny, minimizes immaturity risk in a case of an early successive fire. Cone scales protect the seeds from heat and enable their post-fire dispersal. In the absence of soil seed bank, the canopy stored seed bank is the sole source for regeneration. Higher percentage of serotiny in post-fire regenerating stands and the differences in the germination between seeds from serotinous and non-serotinous cones indicate that serotiny is a fire selected trait. The non-self pruning of dead branches and empty cones increase the probability of high intensity canopy fire with increasing tree age and size. Such canopy fires are essential to create suitable post-fire regeneration niches in the thick ash bed created under the burned canopies. The black color of the seed coat and detachment of the seed wing, decrease post-dispersal predation. The high pH of the ash is responsible for the low density of pine seedlings and near absence of other seedlings. The consequent low competition in the mineral rich environment results in enhanced growth of the pine seedlings. The relatively short longevity and probable decrease in cone production in older age, makes fire an important factor in juvenilization of senescent populations, which is accomplished within about 40 years.

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THE ECOLOGICAL ROLE OF FIRE FOR THE SOUND MANAGEMENT OF *PINUS BRUTIA* TEN. ECOSYSTEMS

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Fire was existing around the planet earth well before the evolution of coniferous forests. Coniferous forests in general and pine forests in particular, were evolved together with the recurring fires and consequently they inherited strong fire adaptations in order to survive and to dominate the site, especially those located where typical Mediterranean climate prevails. These fire adaptations which generally enhance survival and reproduction of the species or the ecosystems involved after fires are to be taken into consideration for the successful management operations. This is also true for the *Pinus brutia* Ten. forest ecosystems along the Mediterranean coasts of Turkey.

As the fire frequencies are increasing, mainly by human induced impacts, the management of fire prone ecosystems gets more complicated and contradictory. As a consequence, the share of the burnt young pine plantations we established is growing unproportionately. The essential reason behind this asymmetric phenomenon is that we, human beings were made to believe that the fire is bad. But we have to learn that ecology does not recognise the definitions and values put by humans since it has its own rules and processes valid for us too. We are to understand ecosystems, not ecosystems to understand us!

PRESCRIBED BURNING AS A FUEL MANAGEMENT TOOL IN *PINUS BRUTIA* TEN. FOREST ECOSYSTEMS AROUND ANTALYA, TURKEY

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The "wildfire fighting policy" of Turkey is generally exclusion oriented which aims to keep the fires away from the pine forests as far as possible. But on the other hand, pine forests need frequent fires to thrive and to survive since the fire is an ecological integral part of these ecosystems. Paradoxically, as the success of wildfire fighting operations develops, the managerial achievement of these ecosystems decreases. The statistical data collected by the forestry department clearly indicates that the intensive wildfire fighting strategy has caused a significant increase in the number of big or escaped fires during the last decades.

Prescribed burning, which is used for many different purposes, can be used in order to control the fuel load (particularly one-hour timelag fuels) within the pine forests whilst meeting the ecological needs of these ecosystems from recurring wildfires. A pioneer study carried out around Antalya / Turkey has shown that the fuel load of the *Pinus brutia* Ten. forests can be reduced at an average magnitude of 78%. An unexpected outcome of this study appeared to be the more comprehensive understanding of the wildfire behavior brought about by the closer examination of fires.

GERMINATION OF *PINUS HALEPENSIS* IN NATURAL HABITATS

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Pinus halepensis has been intensively used for afforestation in Israel during the last 100 years. This species is known to be a dominant tree that invades natural habitats. In recent years several nature reserves in Israel have been invaded by *P. halepensis,* particularly those contiguous to pine planted forests. This gradual invasion is destroying the reserves, endangering many rare and endemic plant species.

In a survey performed at a natural reserve near Jerusalem (650 m a.s.l. and 707 mm rainfall/year), a strong association was found between young trees (1-10 yrs) and shrubs in Terra Rosa and Marl soils, with very few trees in the open spaces. This association suggests that, under these conditions, shrubs play a central role in the germination and establishment of *P. halepensis.* The effects of soil type and shrub microsite on the germination and fate of pine seedling were studied by sowing seeds in the shade of *Cistus villosus* and *C. salvifolius* vs. open spaces, in sites with Terra Rosa and Marl soils. Under the shrubs, % germination was similar in both soils and open sites in Marl, but was reduced to half in open spaces in Terra Rosa. Seedling survival under the shrubs was highest in Marl soils, and was strongly reduced in open spaces, as well as under the shrubs in Terra Rosa. The extensive seedling predation observed under the shrubs in Terra Rosa may explain the lower seedling survival in these conditions, compared to shrubs in Marl soils.

ESTIMATED GENETIC PARAMETERS AND GAIN FOR HEIGHT FROM FOUR YEARS OLD *PINUS BRUTIA* OPEN POLLINATED PROGENY TRIALS

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Seedlings from 168 open pollinated families of *Pinus brutia* Ten. in six clonal seed orchards were planted in three sites in low elevation (0-400 m.) Mediterranean zone. Genetic parameters and gain for height were estimated from these sites. Differential growth responses due to the test sites were present. Narrow sense individual heritability ranged from 0,09 to 0,53 across the test sites. B type genetic correlations among the sites were quite low except that between Fethiye and Antalya. Overall analyses showed that individual narrow sense heritability for height was low (0,14). However estimated genetic gain selecting from best 30 families was 0.11 over the commercial checklots. Family selection appears to be effective for *Pinus brutia* breeding.
Keywords: *Pinus brutia*, selection, height growth, heritability, genetic correlation.

NATURAL AND ARTIFICIAL HYBRIDIZATION BETWEEN *Pinus brutia* x *P. halepensis*. CONSEQUENCES FOR CONSERVATION AND TREE BREEDING

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The two species differ in morphological, anatomical, reproductive, and biochemical characters. Their natural distribution is distinct with well-defined geographical isolation. In many instances, however, when they come in contact, by the introduction of one species in the natural range of the other or are planted together, they hybridize. Under favorable ecological conditions, after the establishment of the initial F_1 hybrids, active introgression has been detected with infiltration of genetic material from one species to the other. This fact raises critical questions concerning the evolution of many natural populations of the two species as well as their conservation. Artificial crosses proved to be successful, only when *Pinus brutia* is the female parent in the cross. In addition, it was recorded that the percentage of sound seeds produced from artificial crosses varies from 5 to 70 percent, in relation to parental trees participating in the cross. Assessment of F_1 hybrids performance in field trials revealed that they exhibit hybrid vigor (heterosis) for growth, which in many cases is impressive (over 100% in volume). Heterosis proved to be directly related with the genotype of the parental trees participating in the cross, and also with the environment where the test was established. In advanced generations, F_2 and back crosses, heterosis breaks down and only few trees perform like the F_1 hybrids.

CONSERVATION AND MANAGEMENT OF *PINUS HALEPENSIS* IN ISRAEL: AN ECOLOGICAL BASIS FOR A NATIONAL PROGRAM

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Aleppo pine *(Pinus halepensis*) has long been part of the natural landscape of Israel. Pine trees were part of the ancient climax vegetation of the region, which was in the form of a Mediterranean woodland dominated by oak trees and other evergreen broad-leaved species. Pine trees appeared, most certainly, as conspicuous individuals emerging from the dense woodland. Heavy human use over the historic periods made pine groves a rare element in the landscape of Israel in the turn of the 20th century. Consequently, afforestation, mostly with *Pinus halepensis* from foreign sources, became a national goal during the pioneering period. Today about 10% of the northern part of the country is planted with pine trees. A national program for the management and conservation of *Pinus halepensis* should take into consideration various aspects: re-establishment of the climax formation; preserving the genetic basis of the native eastern *Pinus halepensis* populations; minimizing the invasive effect of Aleppo pine in nature reserves; minimizing the fire hazard related to dense and decaying pine groves and re-establishment of the native fauna that characterized local pine groves in the past. The paper presents the outline of the national program of *Pinus halepensis* conservation in Israel and elaborates on its ecological rationale.

IS HYBRIDIZATION OF MEDITERRANEAN PINES AN ESCAPE STRATEGY FROM INSECTS IN EVOLUTIONARY TIME?

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Pines in the section Halepenses (*sensu* van der Burgh) predominate in the entire circum-Mediterranean region. Besides the hybridisation readily observed in contact areas of populations of the two constituent species (*Pinus halepensis* and *P. brutia*), putative hybrid phenotypes, on the basis of the intermediacy principle, could be detected even in spots quite distant from boundary regions. This was explained as a result of introgressive hybridisation between the two species and phenotypes were in general clustered in sharply defined groups both on a morphological and needle terpenoid profile basis. Combined field and laboratory bioassays showed that some hybrid phenotypes are significantly resistant against major pine pests such as *Thaumetopoea pityocampa* Denn. & Schiff. and bark beetles such as *Orthotomicus longicollis* Gyll. Hybrid resistance to insect pests is discussed by comparison to other Mediterranean pines in other sections.

EXPERIMENTAL ANALYSIS OF FEEDING PREFERENCE OF *THAUMETOPOEA PITYOCAMPA* (DENN. & SCHIFF.) [LEP., THAUMETOPOEIDAE]

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Pine processionary caterpillar (PPC) is the most important pine defoliator in the entire circum-Mediterranean region. Several pine tree features were suggested to contribute to this such as ecological, morpho-anatomical and chemical. In this study we attempt to find the best model that accounts for the feeding preference of PPC larvae. We combined field experimental designs and laboratory bioassays in specifically designed arenas to investigate the role of individual or combined cues in shaping the feeding preference of the PPC immature stages. The basic experimental protocol involves the performance of behavioural feeding sequences of PPC in arenas with various feeding substrates both natural and chemically modified. The results are analysed by means of canonical discriminant analysis to remove interdependencies between cues and multinomial logistic modelling to estimate the effect of cues on each behavioural step. The examined cues are ecological, morphological, anatomical and chemical volatile metabolites. The relevance of each set of cues and of the "best" combination of the most informative cues was estimated.

GROWTH ANOMALIES ON *PINUS PINEA* AND *PINUS HALEPENSIS* CORRESPONDING TO DRYNESS AND MARINE SPRAY EPISODES

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Forest ecosystems located on sand dunes, represent one of the most threatened ecosystems of semiarid western Mediterranean areas. Dryness and a great increase of tourism activities have produced an important degradation of these ecosystems. The effect of marine spray plays an important role on the development of this community too. In fact, a clear gradient in relation to damage on trees can be found from coastal to inland areas. These damages can be quantified by different degree of canopy defoliation. We collected the samples on a sand dune stand located in Guardamar-Alicante-Spain where 30 trees (*Pinus halepensis* and *Pinus pinea*) were split (5 trees per 2 species per 3 levels of degree marine spray injury). We found moderate to strong climatic signal on *Pinus pinea* and *Pinus halepensis*. Interannual tree growth is strongly related to rainfall of previous year. On the last decade we found a significant increase of missing rings related to degree of defoliation on these two pine species. Finally, we compare the growth curves along this foliar damage gradient.

ROLE OF FIRE ON SEED DISSEMINATION AND GERMINATION OF *PINUS PINASTER* AND *P. RADIATA*

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The genus *Pinus* is one of the most widely distributed on the planet. Within this, *P. pinaster* and *P. radiata* are two of the species that are also widely distributed, above all, because of their recent use for reforestation. Fire is one of the environmental factors that most affect the natural and cultivated populations of *P. pinaster* and *P. radiata*. In this study we have analysed the effect of high temperatures on the opening of cones and germination of seed in both species, the effect of different concentrations of ash on the germination of their seeds, and the effect of the age of the seeds in combination with high temperatures and ash in the germinative response. We have found that the high temperatures cause the cones of *P. pinaster* and *P. radiata* to open without losing the viability of the seed. On the other hand, the high temperatures in the combinations of temperature and time exposure neither stimulate nor inhibit germination. Ash does inhibit germination to a certain degree if large amounts are applied. Finally, the age of the seeds has a different effect in each of the two species studied. In *P. pinaster* no significant differences were observed in the germination of seeds of different ages in any of the treatments applied. However, the oldest seeds from *P. radiata* showed lower germination values than seeds harvested more recently.

PREDICTING POSTFIRE MORTALITY OF *PINUS HALEPENSIS* AND *PINUS PINEA*

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Pinus halepensis and *Pinus pinea* mortality occured after 6 wildfires from 1989 to 1991 in South Eastern France was modeled using data from 998 trees in 13 stands. Logistic regression analysis was used to develop specific models for predicting the probability of mortality as a functiun of tree size and fire-damages descriptors. For both species, probability of mortality increased on one side with increasing percentage of crown scorched and estimated depth of bark charring, and on the other side with decreasing tree DBH. The best fitted and field convenient model was selected for each species. Fire-cause mortality of *P. halepensis* is a function of these three variables and for *P. pinea* is a functiun of the two first variables only. Analysis of receiver operating characteristic (ROC) curves indicated that the selected models perform well for both species with respectivelly 85 and 95 percent concordance between predicted probabilities and observed outcomes. Comparative analysis of fire resistance and survival of the two Mediterranean pine species shows that *P. halepensis* is more fire sensitive than *P. pinea.* Models may be used for planning prescribed burning operations or for salvaging fire-damaged *P. halepensis* or *P. pinea* stands.

DIFFERENTIAL SURVIVAL TO DROUGHT AND SHADE OF TWO PINES AND TWO OAKS: LINKING LEAF PHYSIOLOGY TO WHOLE-PLANT PERFORMANCE

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We have explored survival and responses to light and drought in seedlings of two pines and two oaks in a factorial experiment with four light levels and two watering levels. Watering compensated for the more intense evaporation in the sun, and buffered light and water treatment interactions. Photochemical efficiency estimated by chlorophyll fluorescence revealed only mild photoinhibition in plants of all species grown in the sun, while photochemical efficiency in deep shade was very low, in agreement with poor performance. Photoinhibition in the sun was attenuated in species exhibiting higher carotenoid concentrations. The ratio of chlorophyll a/b was significantly and negatively correlated with survival in deep shade. The mild drought treatment rendered little phenotypic changes relative to the control, well-watered plants. Shade tolerance, estimated from seedling survivorship, was: *Q. pyrenaica* > *Q. robur* = *P. sylvestris* > *P. pinaster*. Phenotypic plasticity was negatively correlated with shade tolerance. Thus, leaf level features and overall phenotypic plasticity in response to light significantly.

ECOPHYSIOLOGICAL PROPERTIES OF ALEPPO PINE PROVENANCES UNDER SEVERE DROUGHT

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Aim of the study was to elucidate eventual differences between ecotypes (genotypes, provenances) in their physiological response to drought. The study was undertaken in two provenance trials: 1. The Yatir forest, annual average rainfall of 278 mm, 2. At Bet Dagan, annual rainfall 556 mm. Significant differences were found within provenance between trials, and within trials between provenances in survival rate, predawn needles water potentials, photosynthesis, sap flow and transpiration, isotopic carbon discrimination. After the very severe drought of the winter 1998/99 of only 144 mm rainfall, survival rate in the year 2000, 15 years after planting, ranged from 0.0% to 59%. Provenances that survived best showed better water use efficiency. Hence, the Yatir afforestation can be looked upon as a peripheral population under strong selection pressure that eliminates homozygous and favours heterozygous genomes (provenances).

WITHIN *PINUS HALEPENSIS* MILL. GENETIC VARIATION AS AFFECTED BY MICROENVIRONMENTS

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We tested whether the F_1-offspring raised from seeds collected in natural native Israeli and in overseas populations of *Pinus halepensis* Mill. planted under semi-arid environmental conditions exhibit genetic diversity and structure similar to those of their parental origin populations. Allele frequencies and genotypes of trees that had survived since planting 15 years ago, and those in the natural populations of origin were determined by two different methods: protein polymorphism by means of starch gel electrophoresis of enzymes, and genomic DNA polymorphism by means of the RAPD and PCR methods. The result of isoenzyme analysis showed that percent polymorphic loci (P%) ranged between 12 and 44% in the natural populations and between 40 and 48% in the populations growing under the stressful environment. Mean value P% increases from 31% in natural forests to 44% in the Yatir populations and, consequently, the mean observed heterozygosity increase from 0.096 to 0.152. RAPD analysis showed that gene diversity (h) rose from between 0.264 and 0.316 in the natural populations to between 0.406 and 0.431 in Yatir. The calculated linear regression between allozyme heterozygosity and gene diversity resulted in r = 0.690, PR<0.001, n=5. Dry-land reforestation in places outside the natural distribution area of a species can be looked upon as peripheral populations with their higher genetic diversity conferred by selection, and thus having more resistance to extreme conditions. Therefore, such reforestation should be treated as a biogenetic resource available for rehabilitation and restoration of damaged Aleppo pine ecosystems.

THE EFFECTS OF TOP PRUNING ON FLOWER AND CONE PRODUCTION IN A TURKISH RED PINE (*PINUS BRUTIA* TEN.) CLONE PARK ESTABLISHED IN ANTALYA, TURKEY

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This study was made to determine the effects of top pruning on flower and cone production in Turkish Red pine (*Pinus brutia* Ten.) Clone Park in Antalya, Düzlerçamı. The experiment design consists of 5 blocks and each block had two parcels in which one of them was pruned, the other one was control. Top pruning was applied by cutting the 15% of total height of the tree.

Top pruning increased the number of female flowers through first two years, but in third year increment was disappeared. At the same time, increasing number of female flowers also increased cone production. Although, male flower production was not significant both in top- pruned and control parcels, the clones that produce a lot of male flower, has decreased the male flower production in the next growth season.

As a result, regarding top pruning provides some help for seed harvest in Turkish Red pine seed orchards; top pruning should be applied with 3 year intervals considering height growth.

THE EFFECT OF LOGGING ON POST-FIRE REGENERATION OF NATURAL *PINUS HALEPENSIS* FOREST

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Natural pine forests regenerate naturally after fire conserving their pre-fire spatial pattern. However, commercial post-fire logging practiced by trunk dragging, may cause severe disturbance to topsoil and thereby diminish this ability. We examine the effects of two post-fire logging regimes on the regeneration of a natural pine forest (*Pinus halepensis)*. The study site, on Mount Carmel Israel, burned in December 1999, and the burned pine trees were logged in June 2000 using three regimes. **Regular logging**: trees were cut and dragged in the regular commercial way. **Cautious logging**: dragging routes avoided the sites of large burned pine trees. **Control**: no logging of the burned pine trees. In each treatment, we counted the pine saplings under the canopies of the large burned pines, measured their height and diameter. We monitored percentage cover of pine saplings and other plant life forms as well as perennial species richness. The preliminary conclusions are: 1. Dragging trunks decreases the number of pine saplings in the regeneration niche under the large burned pine trees. 2. Pine sapling density following **regular logging** could be too low to ensure natural regeneration in the pre-fire spatial pattern. 3.The effect was lower in the cautious logging. 4. Logging also decreased perennial species richness.

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POSTFIRE MANAGEMENT ACTIVITIES AND THEIR EFFECTS ON *PINUS BRUTIA - P. HALEPENSIS* FORESTS

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Rehabilitation measures, salvage logging and reforestation are some of the most common management activities applied in burned pine forests. The effects of these activities on ecosystem structure and function have not been documented well and our studies contribute to fill this gap. In one field site, we evaluate the effects of postfire logging methods on groundcover, vegetation structure and growth as well as soil properties and sediment yield. In the second field site, we assess the effects of postfire rehabilitation methods (log barriers, branch nets, rip-plowing) on groundcover, species diversity and plant growth. We report the first results of our experiments as part of our contribution to the European research program ECOSLOPES. Our results indicate significant effects of postfire activities on measured ecosystem variables.

POSTFIRE NATURAL REGENERATION OF *PINUS BRUTIA* IN THE FOREST PARK OF THESSALONIKI

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The postfire natural regeneration of *Pinus brutia* was investigated in the Forest Park of Thessaloniki (North Greece), after the wildfire of July 1997. After the fire, 800 Ha of the burned area were planted with tree seedlings while the rest were left undisturbed. In undisturbed areas, the mean number of *Pinus brutia* seedlings was 5230 ha^{-1} while in the reforested areas was 1940 ha^{-1}, after two years. Regeneration was higher in east and north aspects compared to south and west ones. The quality of site affected positively and significantly the number of surviving pine seedlings both in planted and undisturbed areas. Two resprouting species, *Quercus coccifera* L. and *Phillyrea latifolia* L. appeared immediately after wildfire and predominated over the rest resprouting species *Pistacia terebinthus* L., *Crataegus monogyna* Jack., *Cercis siliquastrum* L., *Arbutus adrachne* L., *Juniperus oxycedrus* L., *Fraxinus ornus* L., *Anthyllis hermanniae* L., *Pyrus amygdaliformis* Vill.

Keywords: postfire reforestation, natural regeneration, wildfire, resprouted species

LIFE HISTORIES IN MEDITERRANEAN PINES

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The Mediterranean Basin is characterised by the human activity and some ecological factors such as forest fires, drought , soils, etc. that play an important role in the genetic variation of species. We analyse life-history in Spanish pines and their relation with fire as the main disturbance on Mediterranean ecosystems. The primary ecological attributes studied were the canopy seed bank (onset of cone production, percentage and persistence of serotinous cones, cone opening temperature and size of the canopy seed banks), seed and cone morphology, resprouting, bark thickness and self pruning.

Four ecological groups were separated using multivariate cluster analysis and their life-history characteristics are discussed. Serotiny and early flowering in *Pinus halepensis* and *P. pinaster* reflect their evader strategy in relation to fire. Late flowering and absence of serotinous cones in *P. nigra, P. sylvestris* and *P. uncinata* indicate that their natural forest did not evolve under conditions with frequent crown fires. *P. canariensis* and *P. pinea* appear in two single groups for the resprouting capability and the seed size respectively. Intra-specific variation in *P. pinaster* and *P. halepensis* also were analysed under the same perspective.

SEED GERMINATION IN MEDITERRANEAN PINES

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Seed germination strategies play an important role on the regeneration of species especially under contrasting environmental like Mediterranean ecosystems. We analyse inter and intra - specific variation on seed germination in Mediterranean pines (*P. pinaster*, *P. halepensis*, *P. pinea* and *P. nigra*) by means of seed germination test of 15 populations. Intra-population differences on seed germination was also studied in *P. pinaster* population at Teleno Mountain (Northwestern Spain) according to stand altitude, maturation year and crown position.

Differences on seed innate dormancy are related with seed viability, dispersal strategy (time, serotiny...) and ecological factor such as fire, drought and frost. The lack of seed dormancy in non-serotinous species, *P. nigra* and *P. pinea*, (>95% germination at 35 days) allows germination to start after their dispersal time when climatic conditions are favourable for seedling establishment. Seeds of serotinous species, *P. pinaster* and *P. halepensis*, show a high level of variability on germination (30-100%) between and within populations related with summer temperature in maturation year. Diversity of seed innate dormancy length is an efficient mechanism to extend the germination of seeds accumulated on the canopy bank and dispersed after fire.

EARLY POSTFIRE REGENERATION OF A *PINUS BRUTIA* FOREST IN MARMARIS NATIONAL PARK, TURKEY

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Postfire regeneration of a *Pinus brutia* Ten. forest burned in June 1999 was studied in Marmaris National Park, Turkey. The National Park area has a typical Mediterranean climate with hot summers and wet winters. The study was conducted during a year, from September 2000 to September 2001. We established forty 1x1 m plots randomly to evaluate average densities and average cover values of each species found in the forest ecosystem. Average cover of *Cistus* spp. was 26% and *Pinus brutia* seedlings was 2.1% by the first postfire year, and they reached 37.6% and 2.6% respectively by the second postfire year. Density of the resprouter species dominated the study site were relatively lower than the dominant seeder species. Some opportunistic species had been established in the study site by the first postfire year but these species disappeared by the second postfire year. The major height increase in *Pinus brutia* seedlings and in the vegetation occurred in the spring. Although there were some opportunistic species at the study site by the first postfire year, the species composition was not changed considerably after the fire event. As a result, *P. brutia* forests in Marmaris National Park show similar postfire regeneration characteristics with other Mediterranean-type fire-prone pine forests.

WATER TABLE SALINITY, RAINFALL AND WATER USE BY UMBRELLA PINE TREES (*PINUS PINEA* L.)

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The interactions between environmental conditions (particularly precipitation and water table salinity) and tree (*Pinus pinea* L.) water use were studied at the pinewood of Alberese (Grosseto, Italy), a forest stand characterized by a sandy soil and a high water table level (1.0 ÷1.5 m depth). Data on water table (depth and salinity), pine sap flow (by heat pulse technique) were compared between two contrasting sites (A and B). Site A, characterized by low water conductivity values, was located near the karstic Uccellina hills and was likely receiving lateral rainfall drainage. By contrast, the site B, located further away from the hills, showed high values of water conductivity. Rainfall accumulates during winter forming a top layer of fresh water, which is then used by plants during the following spring/summer. When fresh water is exhausted or strongly reduced, upward movement by capillarity of the salty water salinises the entire soil profile at levels dangerous even for highly salt-tolerant plants. Subsequently, autumn rains wash down the salt accumulated in the soil. Pines mainly used the fresh water stored at the top of the water table during the previous winter. When fresh water supplies were depleted, the pines drew from the underlying salty water with clear seasonal differences between the two sites. Pine sap flow greatly declined in the summer in correspondence with increases in surface salinity of the water table at site B, but remained higher and more regular at site A.

DYNAMICS OF GROWTH AND REPRODUCTION IN POSTFIRE REGENERATING ALEPPO PINES (MT PARNES, 1989-2002)

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The early, post-fire regeneration of a 45-yr-old *Pinus halepensis* (Aleppo pine) forest in Mt Parnes, burned in July 1989, has been previously monitored for 3 years (Thanos, Daskalakou & Nikolaidou, J. Veg. Sci. 7, 273-280, 1996). The present study is a follow-up project for the subsequent period 1993-2002. In the same four experimental plots, originally established (winter 1990) at various slopes and exposures, the survival, growth and reproduction of pine saplings was investigated. Measurements were carried out at least once yearly (at the end of the growth season) on randomly selected, tagged individuals (September 1993, 50 saplings per site) and on additional larger samples of pine saplings. Detailed height kinetics for 4 growth periods (Sep 93 – Jul 97) followed sigmoid curves for each yearly growth season while the overall kinetics of the annual growth increment showed an impressive linear regression curve throughout the 13-yr period of study (annual increment: 9.5 cm). Mortality of saplings (1993-2002) was almost negligible in the 3 of the 4 sites (2-8%) while the overall average value was ca. 15%, which would level off the negative exponential curve of survival to a slightly lower value (than in 1992, 20%), ca. 19% (of the initially - end of spring 1990 - established pine seedlings). Finally, the transition of the pine sapling population to the reproduction phase follows a positive exponential curve (starting at year 4 - 0.1% of pines with cones - and approaching 30% at year 13).

COMPARISON OF THE DISTRIBUTION PATTERN BETWEEN POST-FIRE SEEDLINGS OF *PINUS HALEPENSIS* AND *P. NIGRA* SSP. *SALZMANNII*

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The recovery after fire of *Pinus halepensis* forests and those of *P. nigra* ssp. *salzmannii* was investigated in the region around Montpellier (southern France). Sorted at random, 10 sites and 4 sites were studied for *P. halepensis* (5-15 yrs old) and for *P. salzmannii* (17 yrs old) respectively. In each site, the distance of the new seedlings from a seed-bearing tree (outskirts of the unburned forests) was measured on three 60 m^2 (30 x 2 m) transects. The areal distribution pattern of young seedlings was uniform (practically equally distributed in the length of the transects) and in great number (35-285 individuals per transect) in all the studied sites of the *P. halepensis* forests. This was apparently due to the superimposition of seeds from various sources, and at different times after fire. On the contrary, *P. salzmannii* seedlings were generally erratically distributed, or near the seed-bearing tree, and in small number (3-90 individuals per transect). *P. salzmannii* has difficulties to recover after a fire; mortality of young seedlings is high, and the proximity of seed-trees determines seedling establishment. If *P. halepensis* is able to profusely regenerate after fire, *P. salzmanniii* is a very sensitive species.

EFFECT OF GROWING MEDIA ON BIOMASS ACCUMULATION AND NUTRIENT CONCENTRATIONS OF CONTAINERIZED *PINUS HALEPENSIS* M. SEEDLINGS

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Effect of various growing media on biomass accumulation and nutrient concentrations of containerized *Pinus halepensis* seedlings was studied in an open nursery experiment. The experiment was carried out at the State Forest Nursery in the region of N. Chalkidona, North Greece. Treatments involved three types of growing media: peat-perlite (3:1) as a control, peat-peridotite (3:1) and peat-rice hulls (3:1). At the end of the growth period, growing media samples were taken and total concentrations of N, K, Ca, Mg, soluble P, exchangeable cations, pH and loss on ignition were determined. Also, random samples of twelve seedlings per treatment were collected for destructive sampling and the following parameters were assessed: shoot and root biomass and shoot and root nutrient concentrations. The results showed that the peridotite limited the shoot and root dry weights of the seedlings while the rice hulls increased significantly the root dry weights. Shoot and root concentrations of K decreased whereas those of Mg, P, Ca increased in seedlings produced in peat-peridotite. The addition of the rice hulls slightly affected nutrient concentrations of seedlings.

SPATIAL DISTRIBUTION AND CONNECTION OF DIAMETER CLASSES IN *PINUS HALEPENSIS* M. STANDS AFTER WILDFIRE

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Pinus halepensis M. is an exclusively Mediterranean species met in extensive stands in the evergreen-broadleaves zone where this species finds the optimum of its development. The regeneration and maintenance of these stands are influenced by the wildfires, which are the decisive factor for *Pinus halepensis* spread. The natural regeneration of the stands will be continuous and will be principally utilised for their renewal and improvement. The spatial distribution of the trees after the wildfire plays an important role to the structure and treatment of these stands. In this paper the methods for the estimation of spatial distribution and connection among diameter classes of *Pinus halepensis* trees are given. The results from the application of these methods on the diameter classes are useful for the future silvicultural treatment and management planning.

DYNAMICS OF POSTFIRE REGENERATION OF *PINUS BRUTIA* IN PERIURBAN FOREST OF THESSALONIKI, NORTH GREECE

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This paper is dealing with the dynamics of postfire regeneration of *Pinus brutia* Ten. in periurban forest of Thessaloniki, during the period 1988-2002. The first field data have been taken in 1988 from stands partially burned in 1981-1985. These stands were 38 to 48 years old. The new recordings were carried out just after the big wildfire of July 1997 and were continued up today. Both the regeneration characteristics and the young stands dynamics were estimated for each period. The results showed that the regeneration index is especially high at the places of mature stands existing before the fire. The other decisive factor of seedling survival is the favourable soil moisture conditions. The main conclusion drawn out by this research is that postfire regeneration of *Pinus brutia* is satisfactory in good and medium quality sites and only in extremely rocky places is unsuccessful and needs special artificial interventions.

CONTRIBUTION OF THE SEED BANK TO THE REGENERATION OF A COMMUNITY OF *PINUS PINASTER*

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After a disturbance the recovery speed of a plant community and the species composition is determined by the regeneration system of the species present: resprout or sexual reproduction. When the species use obligate sexual reproduction, the soil seed bank necessarily plays an important role in the vegetation dynamic. A community mostly dominated by obligate seeders was studied; it is a *Pinus pinaster* pine stand with accompanying species like *Erica australis,* resprouter*, Chamaespartium tridentatum*, resprouter as well as seeder, *Erica umbellata*, *Calluna vulgaris*, *Halimium lasianthum* and *Genista florida*, all obligate seeders. In September 1998, a large fire occurred in the area after the dry season. 3000 ha were burned in a non-homogeneous manner. The aims of the present study are (1) to investigate the importance of the seed bank in the vegetation recovery of a natural *Pinus pinaster* community burnt in September 1998; (2) to examine the relationship between the seed bank and aboveground vegetation after fire; (3) to discuss the possible impact of the seed bank on the succession process. Thirty soil samples were collected in this area. The indirect method was used to analyse the composition of the soil seed bank. The aboveground vegetation in the field was analysed, determining the plants present and the recovery strategies used by each species. There is a correlation between the composition of the soil seed bank and field vegetation, because the more important species are *Pinus pinaster* and *Halimium lasianthum*.

BIOMASS ALLOCATION PATTERNS IN *PINUS HALEPENSIS* AND *QUERCUS ILEX* SEEDLINGS AS AFFECTED BY ORGANIC AND INORGANIC FERTILIZATION

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Aleppo pine (*Pinus halepensis*) and holm oak (*Quercus ilex* ssp. *ballota*) are the most used conifer and broadleaved species (early and late successional species) in reforestation programs in the Region of Valencia (Eastern Spain). Fertilisation is not a common practice in reforestation in the Mediterranean basin due to the poor productivity of these forests. Soil fertility can be improved by amending the soils with organic residues. Biosolids has been successfully used in high productivity forest plantations and for conservation purposes. We studied short term (20 months) changes in biomass allocation patterns of *Pinus halepensis* and *Quercus ilex* seedlings amended with biosolids and inorganic fertilizers in a field experiment under dry-subhumid Mediterranean conditions. Biosolid application had the highest effects on seedling growth and allocation patterns in both species. The effect was more intense when biosolids were applied with a high content of humidity. Aboveground growth of *Pinus halepensis* seedlings significantly increased in biosolid-amended seedlings, whereas *Quercus ilex* seedlings allocated most of the extra resources belowground. These differences may be related to the contrasted strategy of the two species, and may explain why studies on the aboveground response of slow growing *Quercus* ssp. to increased fertility/biosolid addition frequently fail to detect significant effects.

REFORESTATION WITH MEDITERRANEAN PINES: NEW PERSPECTIVES FOR AN OLD PRACTICE

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Pines have been extensively used in the Mediterranean for land restoration from the late XIX century, as in other parts of the world. The theoretical basis supporting pines utilisation was their stress-tolerant and pioneer features, and their attributed role of facilitating the development of late-successional hardwoods in the long-term. After the 1970's, pine plantations were blamed by conservationist groups of promoting landscape uniformity, wildfires and soil impoverishment.

The use of pines and hardwoods on forest restoration is discussed in the frame of the current disturbance regime and social demands for Mediterranean forests. Large pine forest plantations have recently disappeared in the case of fire-sensitive species (e.g. *Pinus nigra*) or because of short-interval forest fires (e.g. for *Pinus halepensis*). The combined use of pine and oak seedlings in plantations for degraded land restoration is proposed to take advantage of the complementary features of both groups of species. Advanced seeding, nursery techniques for the production of high quality seedlings, soil amendments, and plantation techniques are evaluated for reforestation under water-stressing conditions.

INITIAL RESPONSE OF POST-FIRE *P. PINASTER* AIT. SEEDLING TO TWO TYPES OF HEAVY EARLY THINNING

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A study is being conducted since 1999 in an over-stocked (200.000 seedlings/ha) *P. pinaster* regeneration after a wildfire in 1994 in Galicia (NW Spain) to determine the effect of two thinning intensities (reduction of 78% and 94% of initial seedlings density).

Both treatments have resulted in a similar increase of seedling stem diameter, crown width, stem, twigs and foliage biomass and needle length and mass. The highest relative increment in relation to control (159%) occurred in bole biomass followed by foliage (124%). All these variables showed a trend to decrease their response when thinning intensity increased. No effect was observed on total height and shoot length. Frequency of seedlings bearing strobili decreased for both treatments. Ratios among the mass of different seedling fractions did not show any change due to the thinning, apparently denoting lack of a pronounced effect on the carbon allocation pattern. As a conclusion, both treatments seemed to contribute to seedlings establishment, but the less intense thinning had a lower cost.

PREPLANTING WATER STRESS, PLANTING DEPTH AND WEED CONTROL AFFECTS THE EARLY PERFORMANCE OF *PINUS HALEPENSIS* PLANTATIONS

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In this work we analyse the effect of prolonged plant storage, planting depth and different weed control methods on the early field performance of *Pinus halepensis* plantations. Prolonged plant storage without irrigation strongly reduced seedling water potential and root growth capacity. Plants desiccated to water potentials lower than -2 to –2.5 MPa during their storage showed a significant reduction in survival and growth even when rewatered before plantation. Deep planting under real field conditions reduced field growth but not survival of *Pinus halepensis*. Shoot growth of seedlings with 2/3 and 1/3 of their shoots buried was a 37% and a 15%, respectively, lower than control plants while root growth was depressed 45% and 17%, respectively. Under strong drought conditions, which were simulated in a controlled environment, no survival differences were observed among treatments but largely buried seedlings grew significantly more than unburied plants. Weeds strongly depressed outplanting growth and tended to reduce survival of seedlings in comparison with any weeding method. Herbicides glyphosate and, especially, hexazinone increased more plant growth than hoeing.

PLANT MORPHOLOGY AND OUTPLANTING PERFORMANCE RELATIONSHIPS IN MEDITERRANEAN PINUS SPECIES

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Plants with large shoots and high shoot-root ratios are considered to have a poor performance than smaller seedlings and with low shoot-root ratios in Mediterranean plantations. To test this hypothesis we analysed the relationships between several morphological attributes of seedlings and their outplanting performance in 21 experimental plots of *Pinus pinaster* (7 plots), *P. pinea* (5 plots), *P. halepensis* (7 plots), *P. nigra* (1 plot) and *P. sylvestris* (1 plot). Plots were laid in eight sites with rainfall ranging between 350 and 600 mm per year. In no plot was observed a negative and significant (r^2>0,1 and α=0.1) relationship between shoot size (height, diameter, volume, dry weight) and field growth or survival. A positive and significant relationship between shoot size and field growth was observed in 37 to 59% of all the plots and in only 14 to 23% of the plots there existed a positive relation with survival. A negative relation between shoot-root ratio and survival could only be observed in one plot. When considering species separately, *P. halepensis* showed little and poor morphology-field performance relationships whereas in many of the *P. pinaster* and *P. pinea* plots we found significant and positive relationships between shoot size and field growth.

POSTFIRE REGENERATION OF ALEPPO PINE ECOSYSTEMS IN SITHONIA PENINSULA, NORTH GREECE

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This paper deals with the postfire restoration of Aleppo pine ecosystems in Sithonia Peninsula, North Greece. The pre-burning stands consisted of two storeys; the overstorey of the dominant species Aleppo pine and the understorey of maquis. The wildfire in the area has taken place in June 1994 and just after the fire the monitoring of the vegetation dynamics has started. In the winter 1994-1995 two blocks of a size 0.4 ha were established in a northern and southern slope respectively. In the sampling plots of the blocks different restoration methods were applied, using Aleppo pine reproductive material, as follows: i. planting of bare root seedlings, ii. planting of paper-pots seedlings, iii. seeding in patches, iv. seeding in lines, v. seeding in belts. The results of all these treatments were evaluated until the spring of 2002 in comparison with control plots, which have been left to the natural process. The results show that all the applied restoration works accelerated the revegetation of the area, while the best results gave the method of paper-pots plantings.

PATTERN AND PROCESS IN IBERIAN MIXED PINE-OAK FORESTS: INSIGHTS ON COEXISTENCE MECHANISMS OF MEDITERRANEAN PLANT COMMUNITIES

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Aleppo pine - holm oak forest is one of the most widespread forest communities in Eastern Iberian Peninsula. Landscape patterns in these forests reveal strong species segregation along a drought length gradient, both in the mean and in the variance. The mechanisms that generate and maintain these patterns were evaluated in terms of how critical stages along the plant cycle -- chiefly seedling establishment and light competition at the sapling stage -- influence final stand composition. A simple mean-field discrete-time model shows that changes in stand composition along aridity and disturbance gradients can be explained in terms of shifts in ecological interactions along the gradients from facilitation to competition. Model analyses also reveal the importance of the sapling stage. A more realistic spatially explicit individual based simulator, calibrated with sapling growth and mortality field data, allows us to predict both stand production and composition along disturbance and aridity gradients. The role of water balance in structuring plant communities is discussed in the context of current ecological theory.

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