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National and Kapodistrian University of Athens
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4th Mediterranean Plant Conservation Week
VALÈNCIA | 23-27 OCTOBER | 2023

Research priorities for *ex situ* and *in situ* conservation on the East Mediterranean coniferous forests

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Global

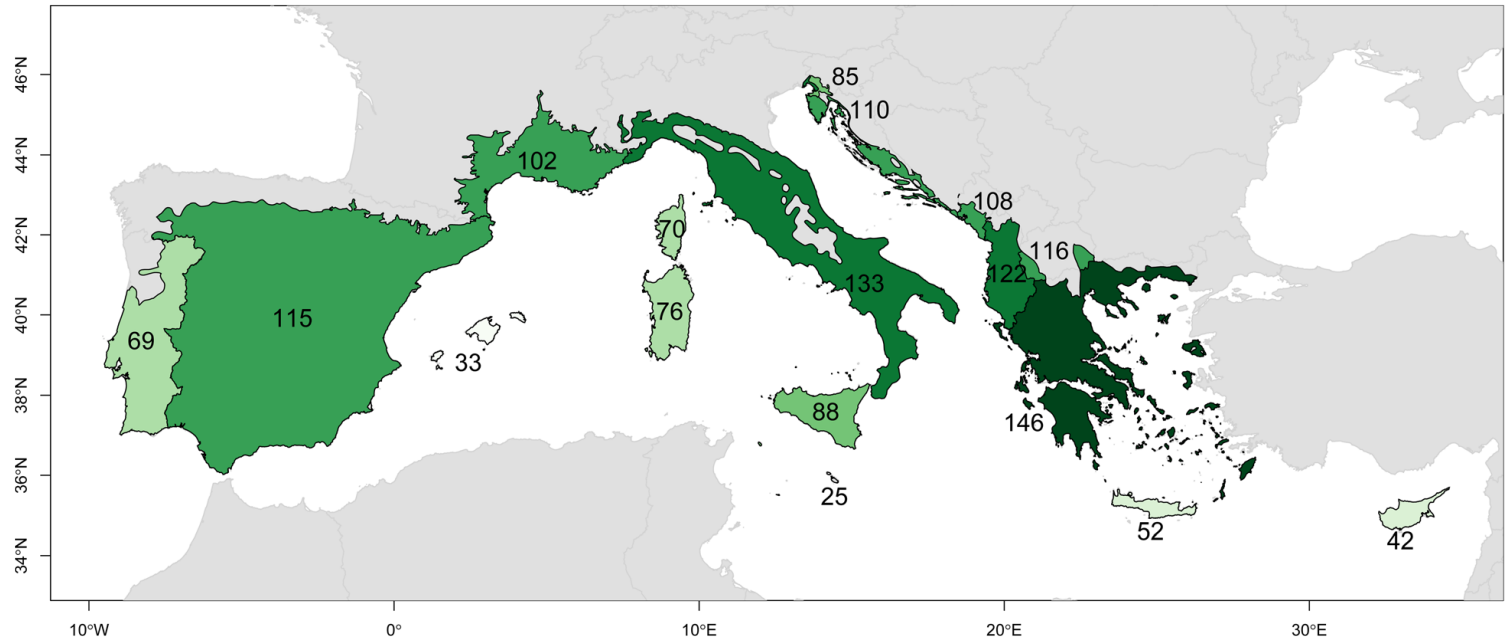
ca. 60,000 tree species; > 600 conifers

forest distribution; plants and animals; biodiversity and carbon storage

Mediterranean-European region

245 tree taxa [210 sp. & 35 ssp., including 46 endemics (30 sp. & 16 ssp.)]

Pinus, Abies, Cupressus, Juniperus, Cedrus and *Taxus* spp.

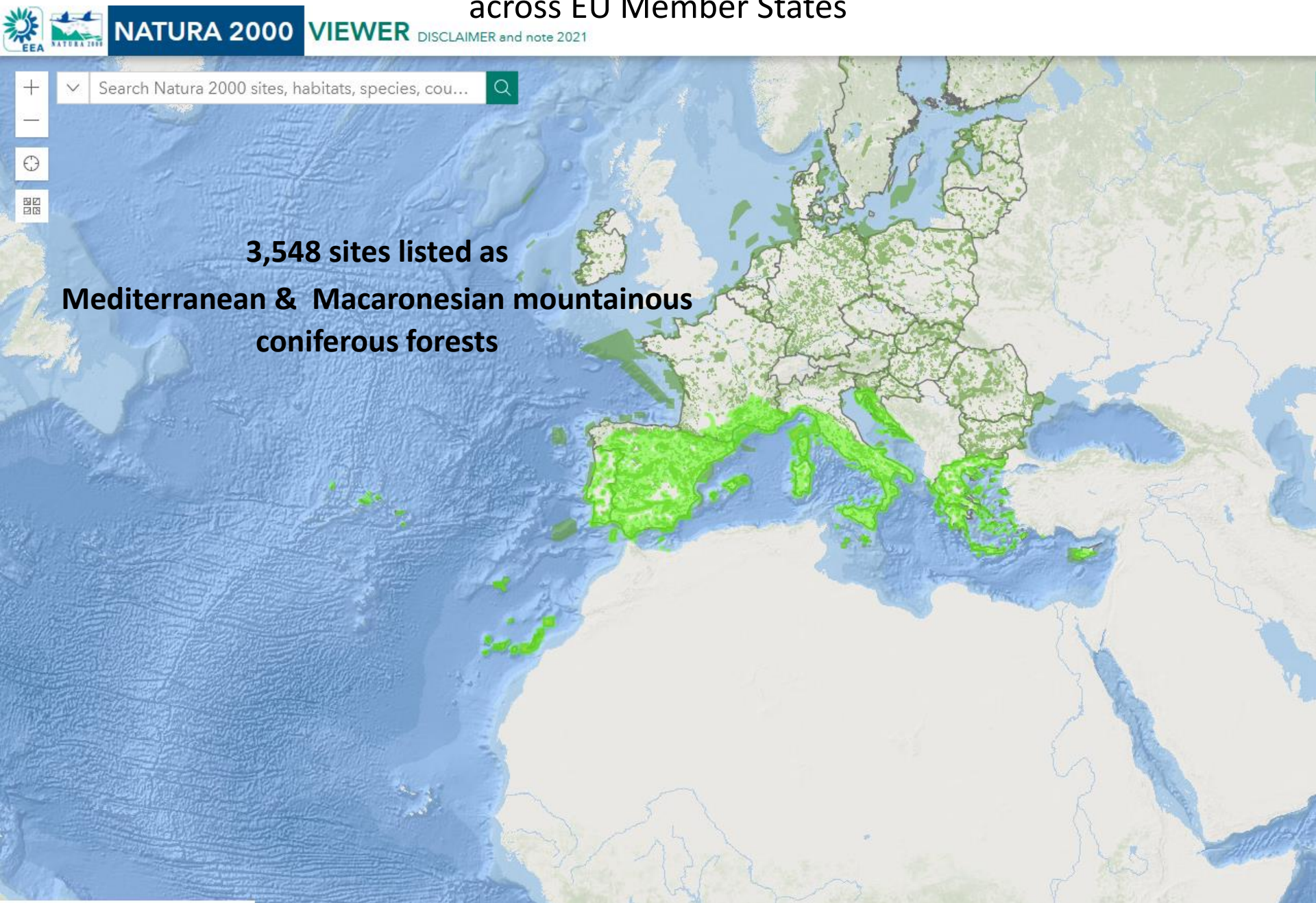


Number of native tree taxa (species or subspecies - including endemic and putative native) in each continental administrative area and main islands in the Mediterranean-European region. Darker greens indicate higher richness.

tree diversity, distribution and conservation status at a global scale?

Farjon (2018); Médail et al. (2019); Beech et al. (2021); BGCI (2021) State of the World's Trees

Natura 2000 network with 23,650 sites protecting habitats and species (excl. birds) across EU Member States



COUNCIL DIRECTIVE 92/43/EEC - ANNEX I
NATURAL HABITAT TYPES OF COMMUNITY INTEREST WHOSE CONSERVATION REQUIRES THE DESIGNATION OF SPECIAL AREAS OF CONSERVATION

95. Mediterranean and Macaronesian mountainous coniferous forests

9510 * Southern Apennine *Abies alba* forests

9520 *Abies pinsapo* forests

9530 * (Sub-) Mediterranean pine forests with endemic black pines

9540 Mediterranean pine forests with endemic Mesogean pines

9550 Canarian endemic pine forests

9560 * Endemic forests with *Juniperus* spp.

9570 * *Tetraclinis articulata* forests

9580 * Mediterranean *Taxus baccata* woods

9590 * *Cedrus brevifolia* forests (Cedrosetum brevifoliae)

95A0 High oro-Mediterranean pine forests

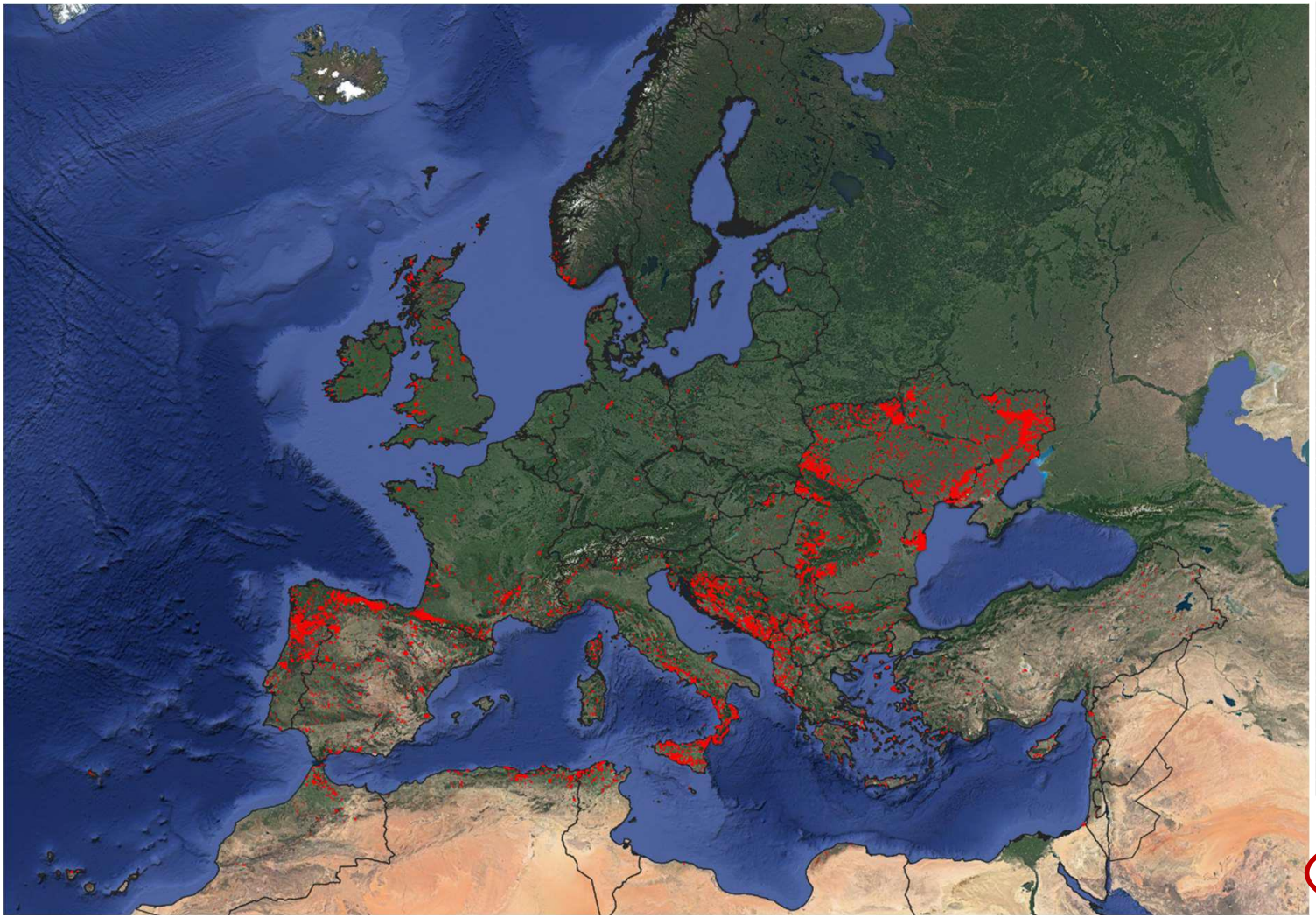


Table 1. Areas mapped in 2022 estimated from satellite imagery.

Country	Area (Ha)	Number of Fires
Albania	19591	307
Algeria	53148	157
Austria	1034	8
Belgium	428	7
Bosnia	76473	578
Bulgaria	15461	150
Croatia	34818	290
Cyprus	2650	23
Czechia	1438	2
Denmark	510	30
Egypt	2163	13
Estonia	2	1
Finland	372	33
France	74654	1089
Germany	5117	115
Greece	23942	230
Hungary	7960	92
Ireland	3409	69
Israel	239	5
Italy	68510	1426
Kosovo	4430	98
Latvia	238	14
Lebanon	249	22
Libya	207	9
Lithuania	34	7
Malta	23	2
Montenegro	26332	260
Morocco	32680	103
Netherlands	331	15
North Macedonia	4261	74
Norway	2867	84
Poland	675	39
Portugal	112063	1236
Romania	162518	1432
Serbia	13292	235
Slovakia	374	10
Slovenia	4431	7
Spain	315705	1490
Sweden	515	37
Switzerland	235	2
Syria	596	21
Tunisia	11745	155
Türkiye	17055	195
UK	22895	460
Ukraine	*498711*	*6309*
Total	**1624381**	**16941**

Summary	Total Area (Ha)
EU27	837212
Other European countries	686142
Middle East and North Africa	101027
Natura2000 sites	365308

Burnt scars produced by forest fires during the 2022 fire season.

San-Miguel-Ayanz et al. (2023)

9540 Mediterranean pine forests with endemic Mesogean pines

Pinus halepensis Mill.

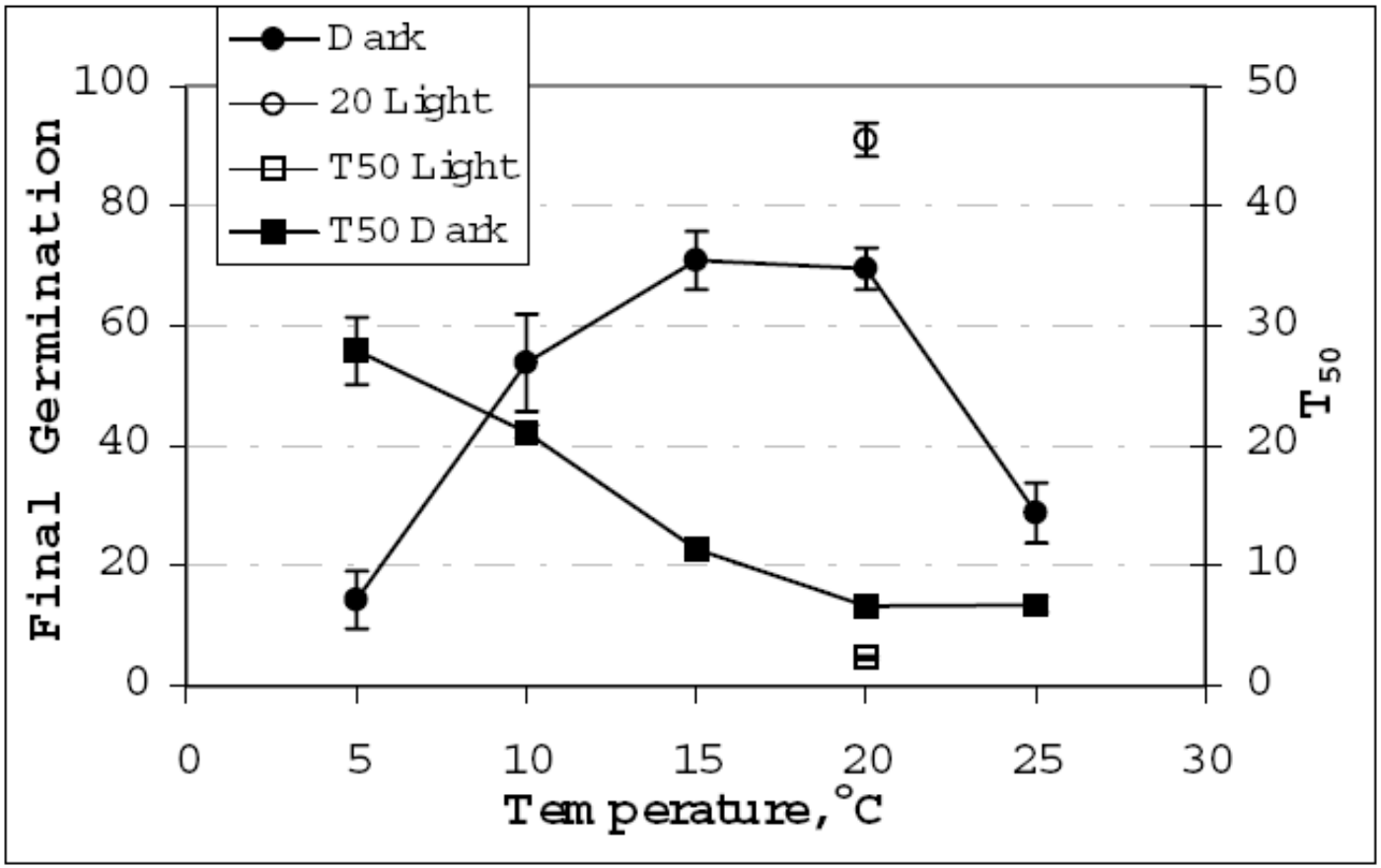
Pinus brutia Ten.

Quézel (2000)

9530 * (Sub-) Mediterranean pine forests with endemic black pines

Pinus nigra J.F. Arnold

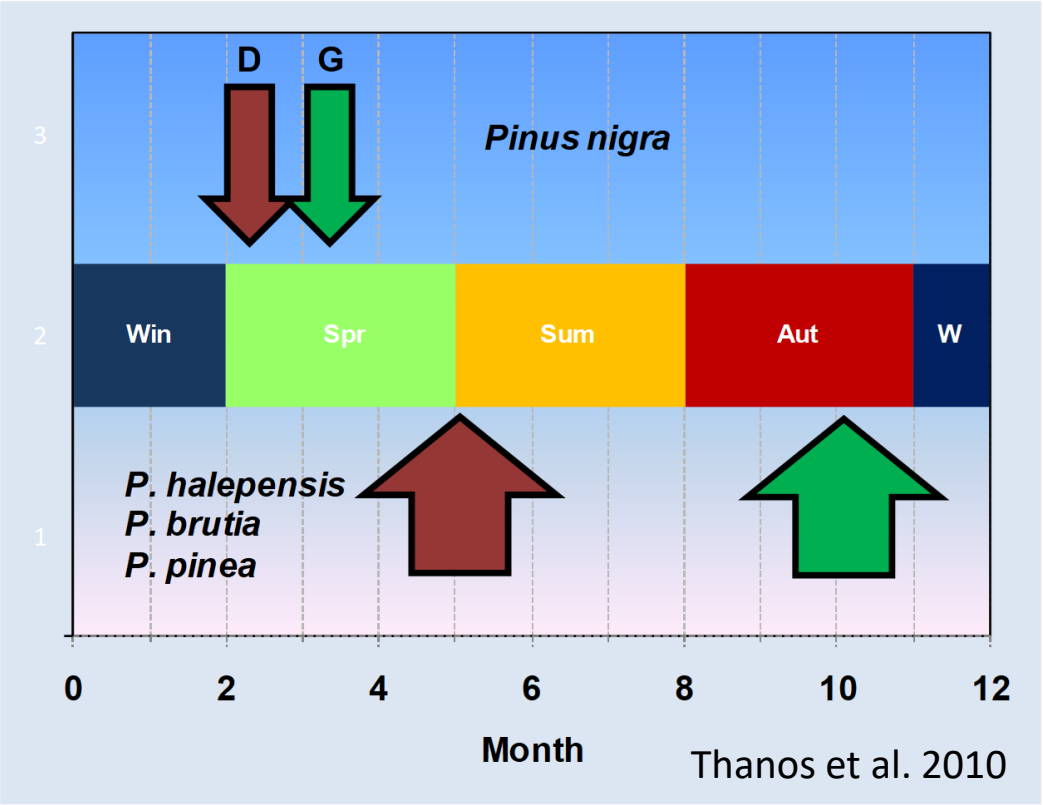
9530 * (Sub-) Mediterranean pine forests with endemic black pines



Final germination percentage for each temperature tested; average values from 11 Greek populations studied. Average T_{50} values are also pooled for each temperature. Vertical lines on each point represent ± SE values.

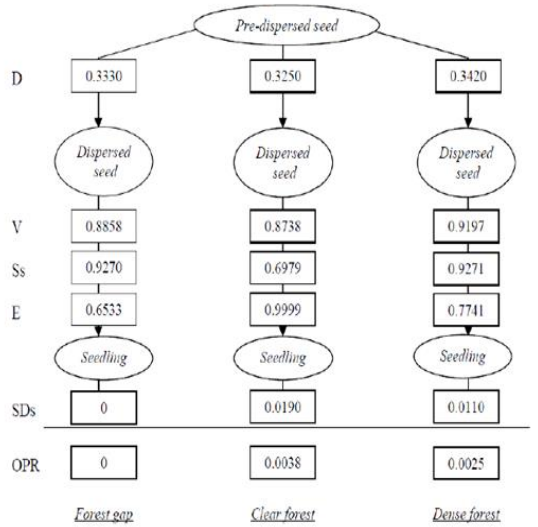
Panayiotopoulos & Thanos (2002)

9530 * (Sub-) Mediterranean pine forests with endemic black pines



Thanos et al. 2010

Figure 3. Diagram of the spatial dynamics of recruitment in each one of the microhabitats considered. Ovals represent the stages and rectangles the processes of recruitment analyzed. Values shown are process-specific transition probabilities (TPs). OPR represents the overall probability of recruitment at each microhabitat. D = seed dispersal; V = seed viability; S_s = post-dispersal seed survival; E = seedling emergence; SD_s = seedling survival.



(Tíscar & Linares 2011)

P. nigra cones are not serotinous;

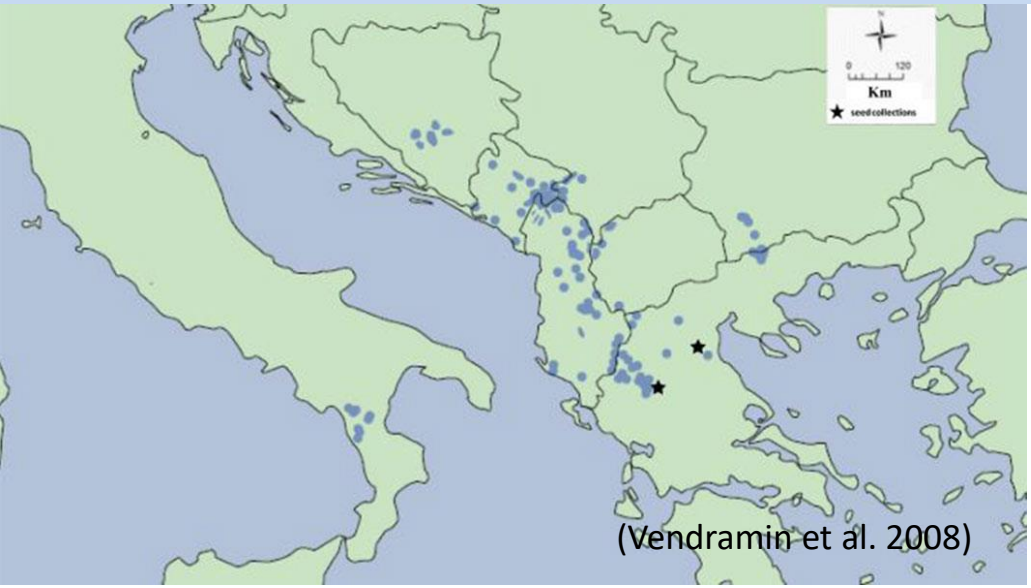
post-fire pine populations are limited (Tavsanoglu et al. 2010);

masting years (Ordóñez et al. 2006; Isajev et al. 2011; Lucas-Borja et al. 2012; Christopoulou 2014);

rare surface fires may play a role in preventing successional replacement on productive sites (Nagel & Cerioni 2023)

95A0 High oro-Mediterranean pine forests

95A0 High oro-Mediterranean pine forests



(Vendramin et al. 2008)

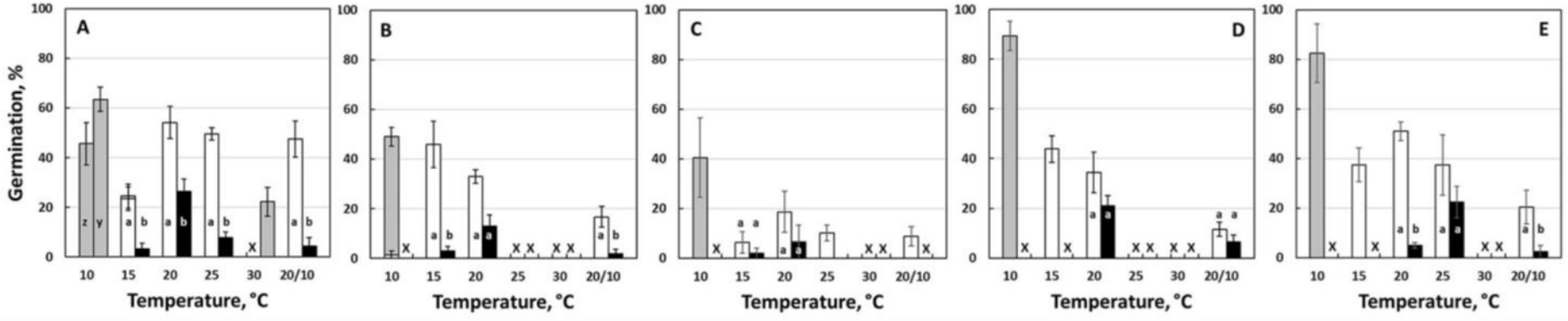


Fig. 4 - Final germination in untreated (non-stratified) *Pinus heldreichii* seeds, tested over a range of constant (10, 15, 20, 25 and 30 °C) and alternating temperatures (20/10°C), in the light (12 h photoperiod, white bars) or in continuous darkness (black bars). Different small-case letter labels indicate significantly different values between light and dark treatments within each temperature ($p < 0.05$). Results from Pindos Range collections are shown in graphs A (collection year 2011), B (2012) and C (2013), while Mt. Olympus collections appear in graphs D (2012) and E (2013). Non germinated (untreated) seeds of the non-stratified treatment were subsequently transferred as follows: (i) from 10 (L/D and D), 15 (L/D) and 30 °C (D) to 20/10 °C L/D for batch A; and (ii) from 10 °C L/D to 20 °C L/D for batches B-E (results are presented by grey bars). The "×" mark indicates lack of experimental data in the respective germination conditions.

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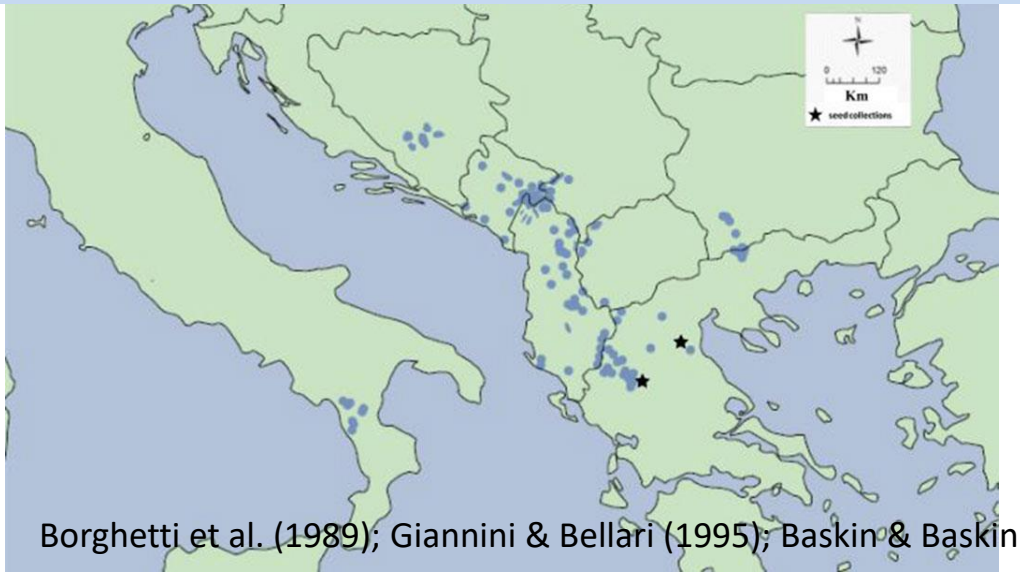
Research Article
doi: 10.3832/ifor4045-015
vol. 15, pp. 331-338

Seed germination traits of *Pinus heldreichii* in two Greek populations and implications for conservation

Evangelia N Daskalakou [(1)],
Katerina Koutsovoulou [(2-3)],
Spyridon Oikonomidis [(1-2)],
Costas A Thanos [(2)]

Seed germination traits were assessed on *Pinus heldreichii* H. Christ, a Tertiary relict, high-elevation Mediterranean pine, endemic in the western Balkan Peninsula and southern Italy; it is naturally grown at the northern Greece mountains, but also found in shrubby form above the timberline. Closed and mature cones were collected (October) for three consecutive years from Pindos Range and Mt. Olympus populations. Cone and seed morphological traits were recorded along with the seedling cotyledon number. Seed germination

95A0 High oro-Mediterranean pine forests



Borghetti et al. (1989); Giannini & Bellari (1995); Baskin & Baskin (2014)

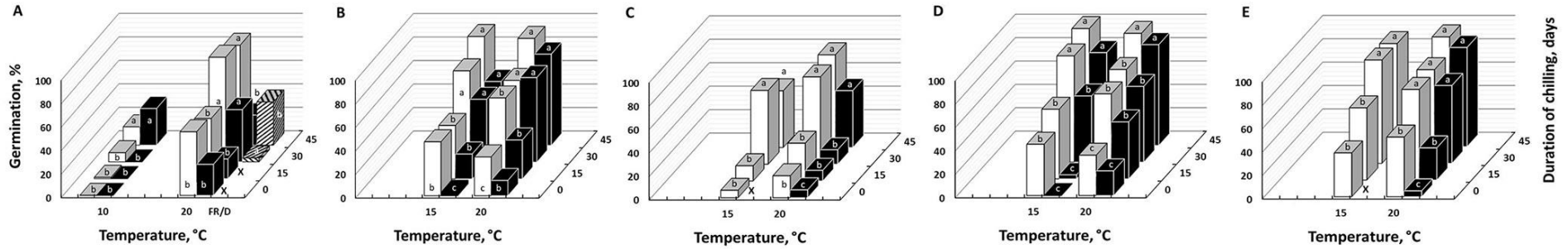


Fig. 5 - Effect of various chilling durations (0, 15, 30 or 45 days) on final germination of *Pinus heldreichii* seeds at 10, 15 and 20 °C, under white light (12 h photoperiod, white bars), dark (black bars) and Far Red light (spotted bars). Different small-case letter labels indicate statistically significant differences among germination values obtained by different chilling durations within each temperature ($p < 0.05$). Results from Pindos Range collections are in graphs A (2011), B (2012) and C (2013), while collections from Mt. Olympus appear in graphs D (2012) and E (2013). The "×" mark indicates lack of experimental data in the respective germination conditions.

particularly vulnerable populations at lower altitudes;

ex situ (*e.g.*, germplasm conservation) and *in situ* measures (*e.g.*, selection for drought tolerance)

masting years (Stojičić et al. 2008)

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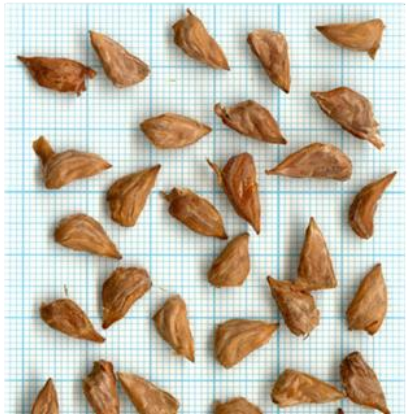
9590 * *Cedrus brevifolia* forests (Cedrosetum brevifoliae)

Vidakovic (1982); Boydak (2003)

9590 * *Cedrus brevifolia* forests (Cedrosetum brevifoliae)



masting behaviour

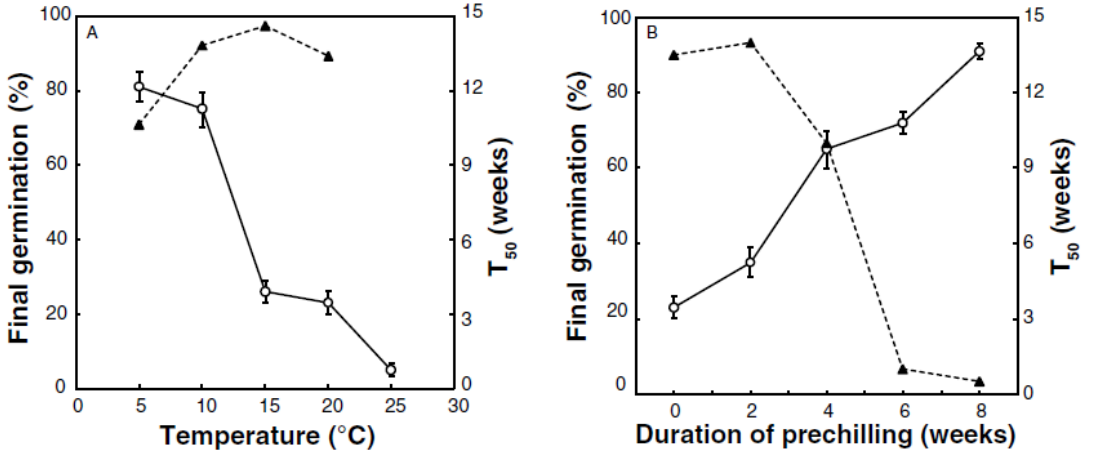


Figure 3. Final germination in untreated and prechilled *Cedrus brevifolia* seeds. (A): Final dark germination (solid line) and time for 50% of final germination (dotted line) as a function of temperature, in untreated seeds. (B): The effect of chilling on final dark germination (solid line) and time for 50% of final germination (dotted line); seeds were imbibed for increasing periods of time at 5°C and subsequently transferred to 20°C (in darkness throughout).

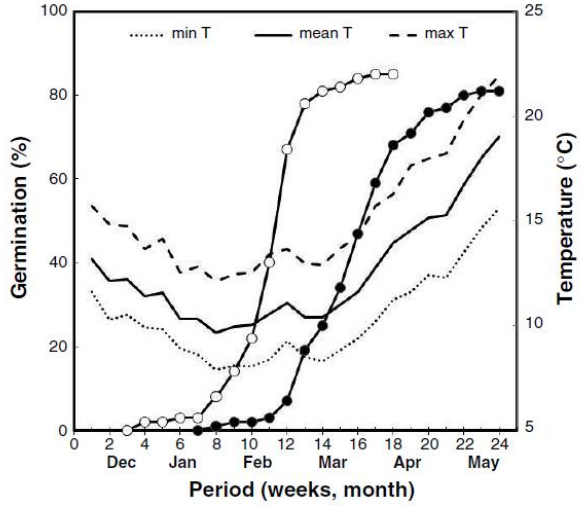


Figure 4. Time course of seed germination in *Cedrus brevifolia* under experimental conditions roughly simulating those prevailing in the field, during December-May. Seeds were imbibed in darkness (closed circles) or received light during the day (open circles). The temperature conditions shown are those of the Meteorological Station of Ellinikon, Athens, Greece.

Koutsovoulou et al. (2013); Kounnamas (2021)

Daskalakou, E.N., Thanos, C.A. and Georghiou, K. (2015), *Seed Sci. & Technol.*, **43**, 378-389.
http://doi.org/10.15258/sst.2015.43.3.05

Seed biology, reproductive phenology and conservation of *Cedrus brevifolia*, a threatened endemic tree of Cyprus

E.N. DASKALAKOU[1], C.A. THANOS[2] AND K. GEORGHIOU[2]*

9560 * Endemic forests with *Juniperus* spp.

Juniperus drupacea Labill.

9560 * Endemic forests with *Juniperus* spp.

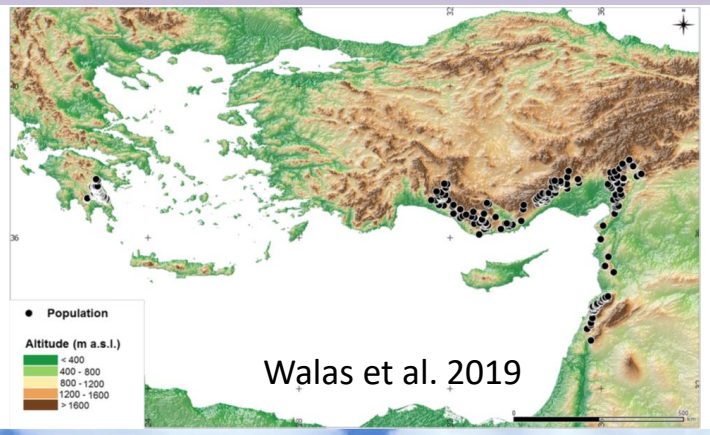
Juniperus drupacea

IUCN
globally ‘Least Concern’ (LC),
in Europe ‘Endangered’ (EN)

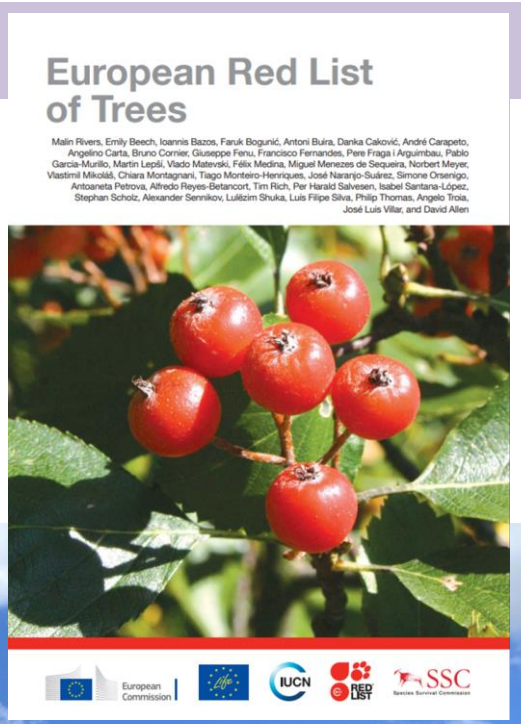
Directive 92/43/EEC
priority habitat (9560*)

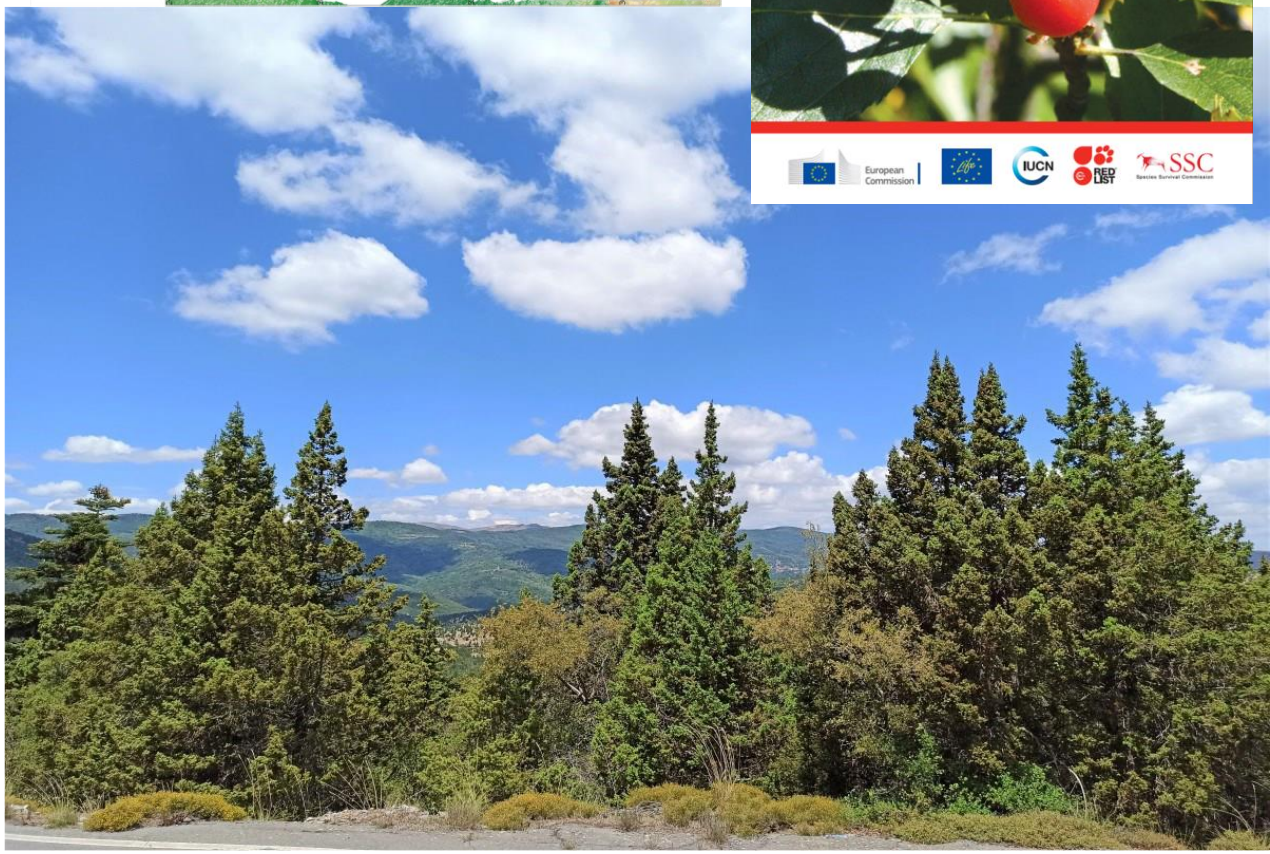
national level
Presidential Decree 67/1981
Natura 2000 Network
(GR2520006)

threats
grazing of saplings,
wood overexploitation &
climate change.



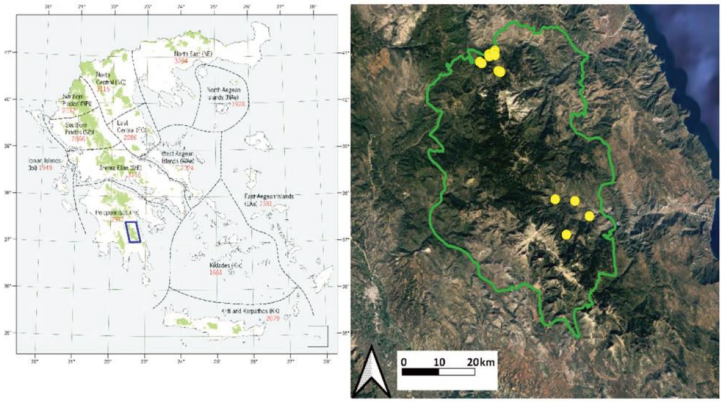
Walas et al. 2019

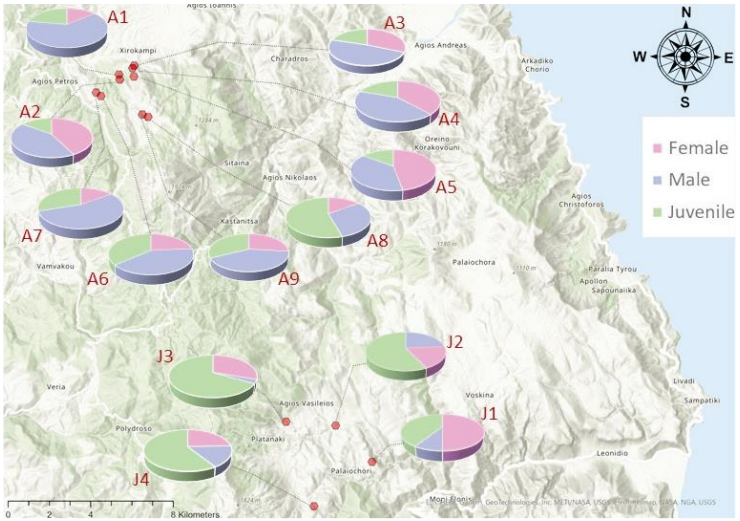




Gardner (2017); Rivers et al. (2019)

9560 * Endemic forests with *Juniperus* spp.





Article

Fl. Medit. 32: x-xxx
https://doi.org/10.7320/FlMedit32.000
Version of Record published online on xx December 2022

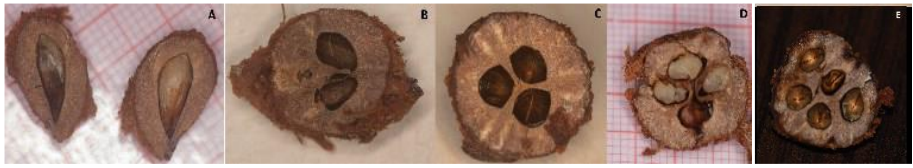
E. N. Daskalakou, S. Oikonomidis, S. Boutsios, K. Ioannidis, & C. A. Thanos

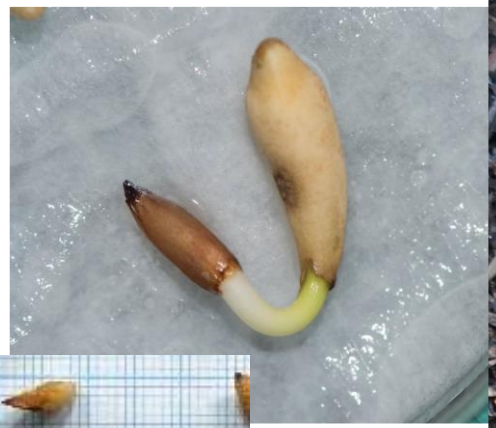
Population characteristics of *Juniperus drupacea* (*Cupressaceae*) at the westernmost marginal area of its world distribution (Mt. Parnon, Greece)

9560 * Endemic forests with *Juniperus* spp.

Juniperus drupacea

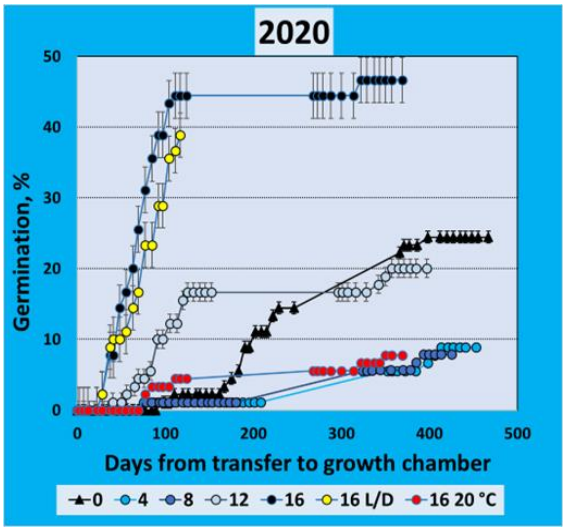
cone/seed collections (Oct-Nov)
2020-2023

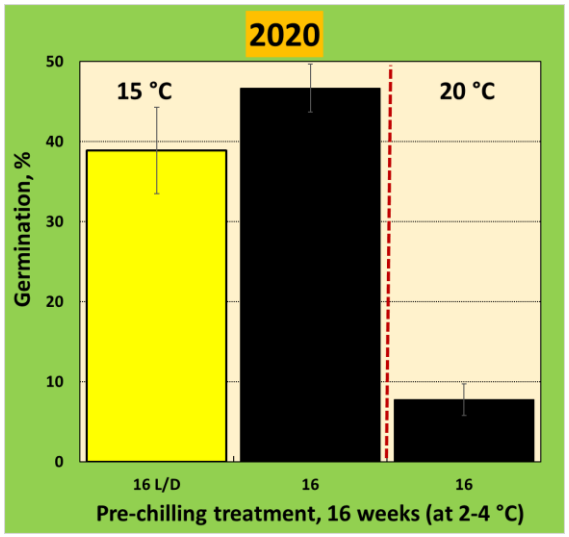


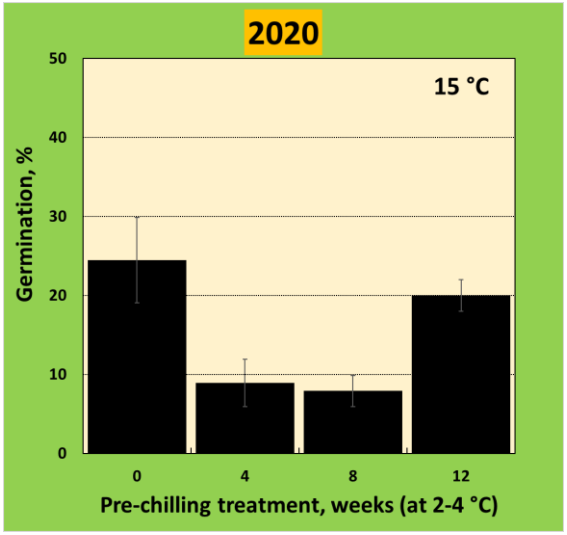


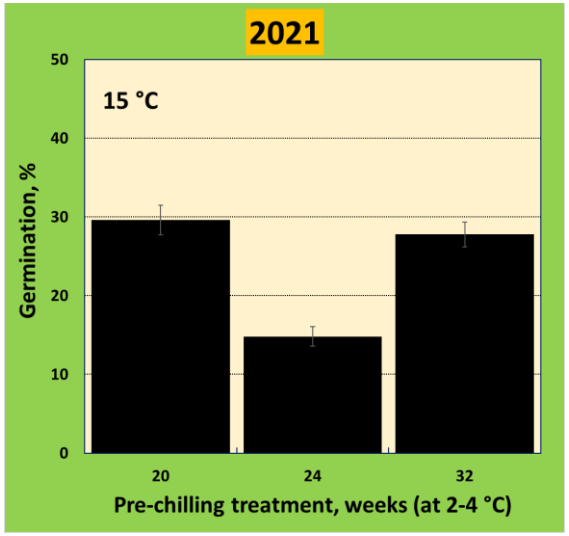
9560 * Endemic forests with *Juniperus* spp.

plant growth chambers (BINDER KBW 240, Germany)
ecologically meaningful temperatures (15 & 20 °C)
8 pre-chilling regimes (0, 4, 8, 12, 16, 20, 24, 32 w at 5 °C) in darkness → at 15 °C
16 w pre-chilling period L/D (12:12 h) and D → at 20 °C









viable and can start germinating at low temperatures (5 °C),

although significantly prolonged, e.g. after a pre-chilling period over 20 w,

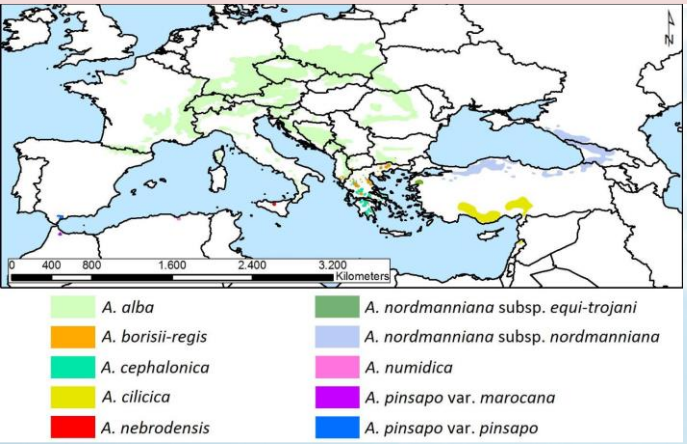
a pre-chilling period e.g. over 8 w promote germination

at least 16 w is necessary for achieving the maximum germination percentage (>40%) at 15 °C

… on going experiments with 2022 & 2023 seed lots

Oikonomidis et al. (2022)

951B *Abies cephalonica* forests



López-Tirado et al. (2023)

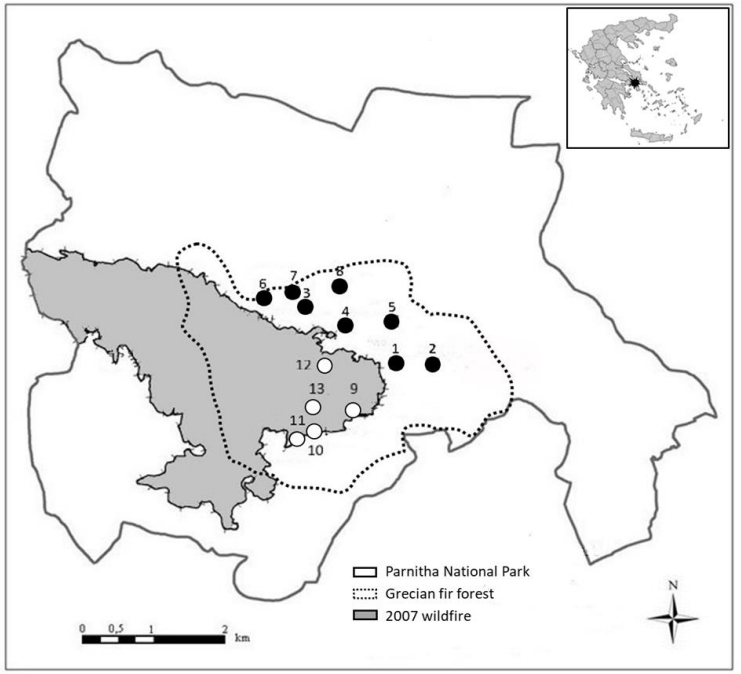
I. masting years

13 plots established (May 2013) for long-term monitoring in Parnitha NP

- 8 inside the unburned *Abies cephalonica* mature forest (filled circles) and
- 5 within the unburned 'islets' (open circles)

at randomly selected sites of varying altitudes, exposures and slopes.

WILDFIRE summer 2007



Seed Science Research

cambridge.org/ssr

Research Paper

Cite this article: Daskalakou EN,

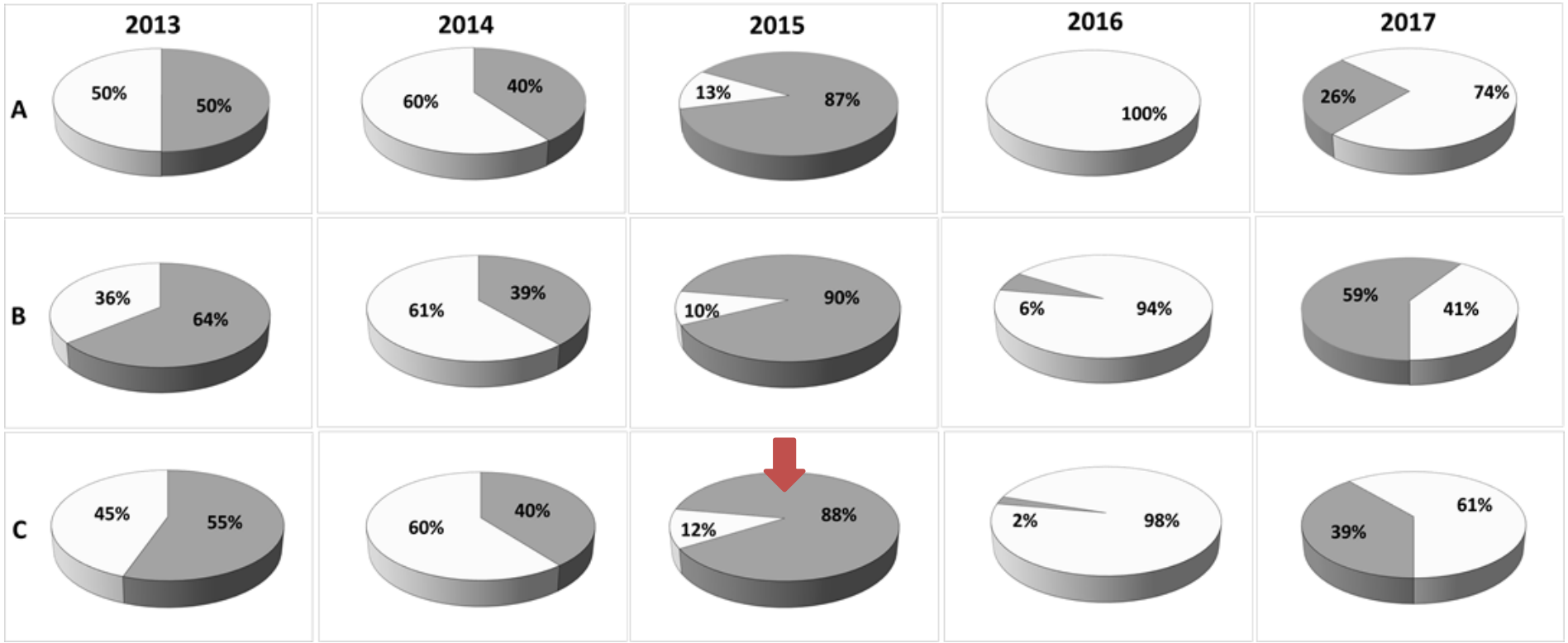
Masting and regeneration dynamics of *Abies cephalonica*, the Greek endemic silver fir

Evangelia N. Daskalakou[1*], Katerina Koutsovoulou[2,3], Kostas Ioannidis[1], Panagiotis P. Koulelis[1], Petros Ganatsas[4] and Costas A. Thanos[2]

[1]Institute of Mediterranean & Forest Ecosystems, Hellenic Agricultural Organization 'DEMETER', Terma Alkmanos

951B *Abies cephalonica* forests

Annual cone-bearing incidence of *Abies cephalonica* forest in Parnitha NP



Mature, closed cones (brown cones) were counted in autumn (September-October), in the unburned forest (A, n=80), the unburned 'islets' (B, n=50) and the accumulated, total number of monitoring plots (C, n=130 trees).

II. Seed germination

CONE COLLECTION

Freshly matured closed cones (~ 60 cones, ca 20 trees) were collected in autumn (Oct) for 8 consecutive years (2007–2015, 2011 excluded)

- ✓ cone and seed biometrics
- ✓ empty, infertile/insect infested & dead seeds
- ✓ seed viability and germination

Seed Science Research

cambridge.org/ssr

Research Paper

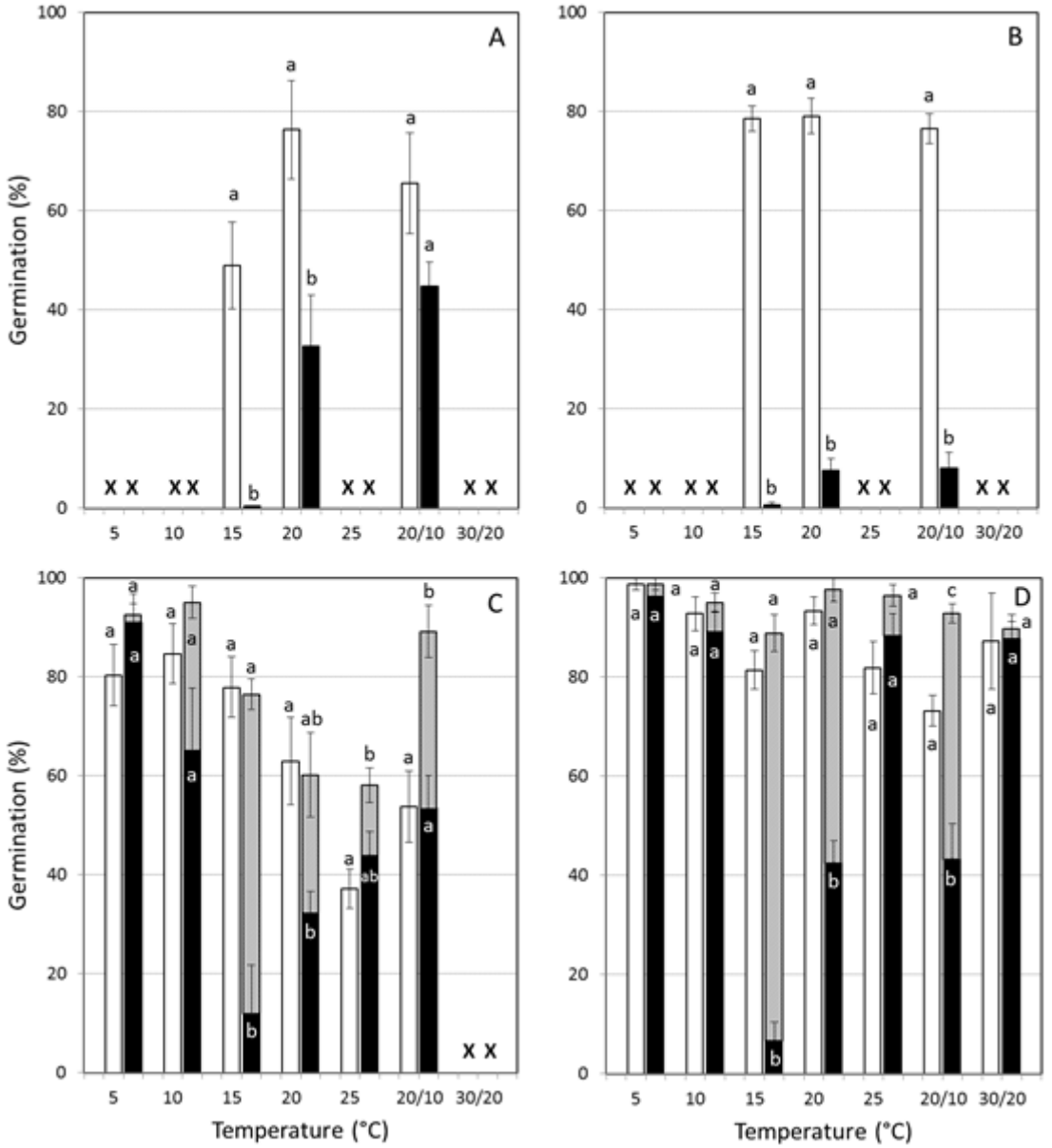
Cite this article: Daskalakou EN, Koutsovoulou K, Mavroeidi L, Tsiamitas C, Kafali E, Radaiou P-E, Ganatsas P, Thanos CA (2018). Interannual variability of germination and cone/seed morphometric characteristics

Interannual variability of germination and cone/seed morphometric characteristics in the endemic Grecian fir (*Abies cephalonica*) over an 8-year-long study

Evangelia N. Daskalakou[1], Katerina Koutsovoulou[2], Lida Mavroeidi[2], Charalambos Tsiamitas[2], Eleftheria Kafali[2], Panagiota-Effrosyni Radaiou[2], Petros Ganatsas[3] and Costas A. Thanos[2]

951B *Abies cephalonica* forests

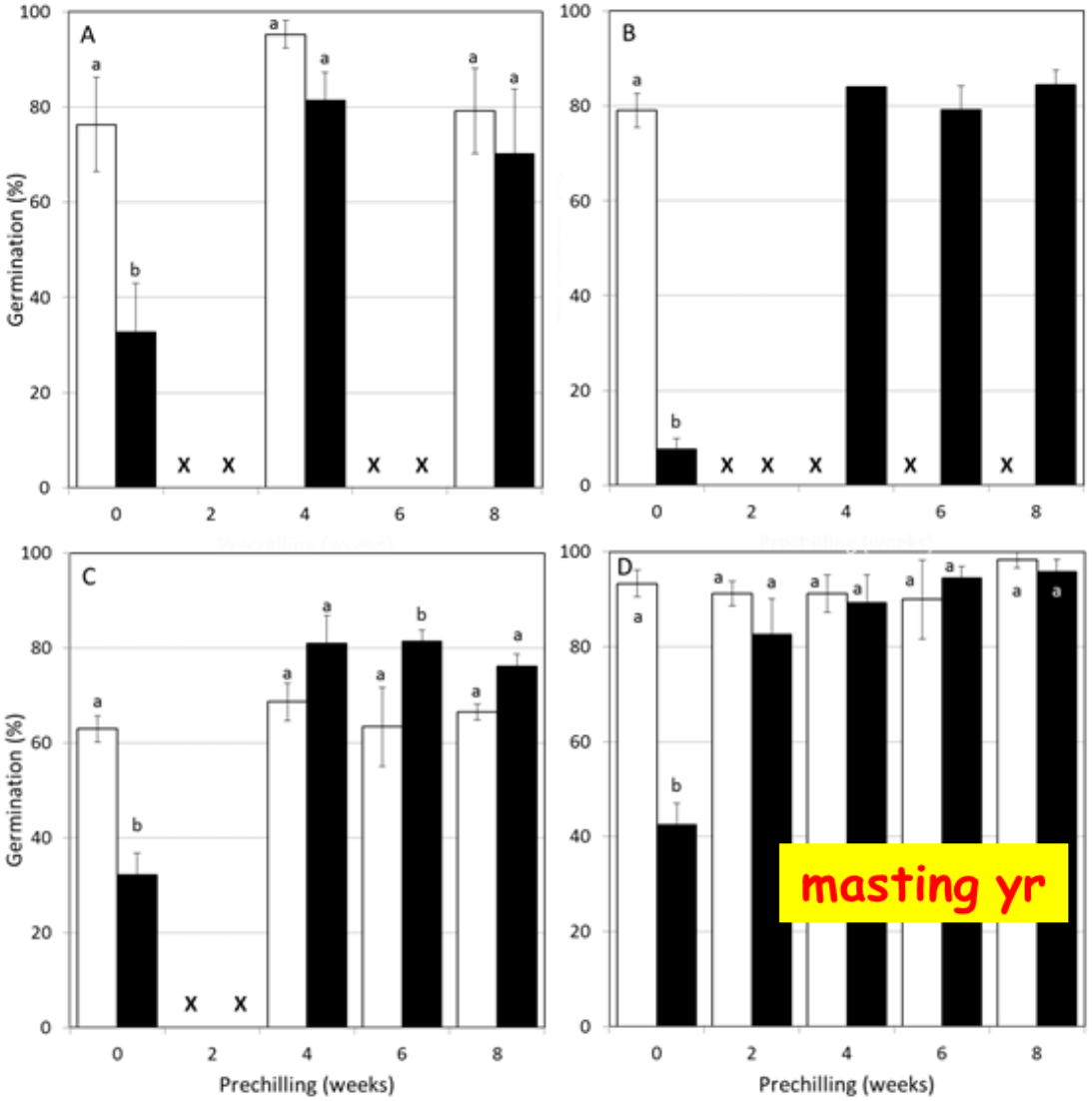
untreated seeds



masting yr

951B *Abies cephalonica* forests

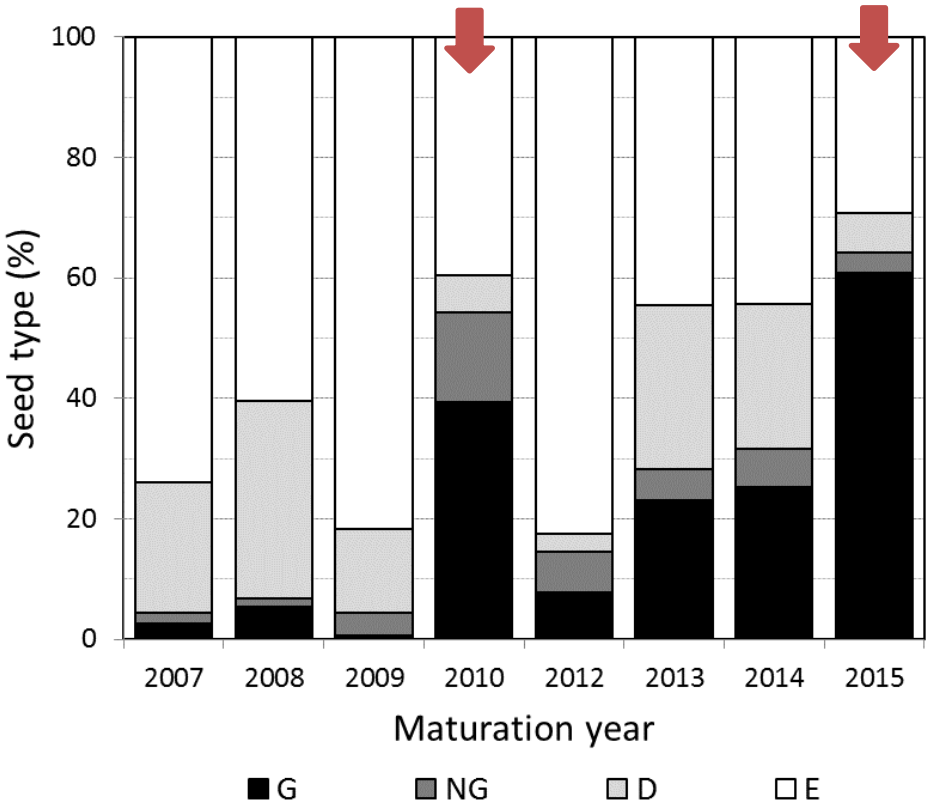
chilling pretreatment 0, 2, 4, 6 & 8 w ⟶ 20°C L/D, cD



951B *Abies cephalonica* forests

seed classification for an 8-yr post-fire period

masting years
2010 & 2015

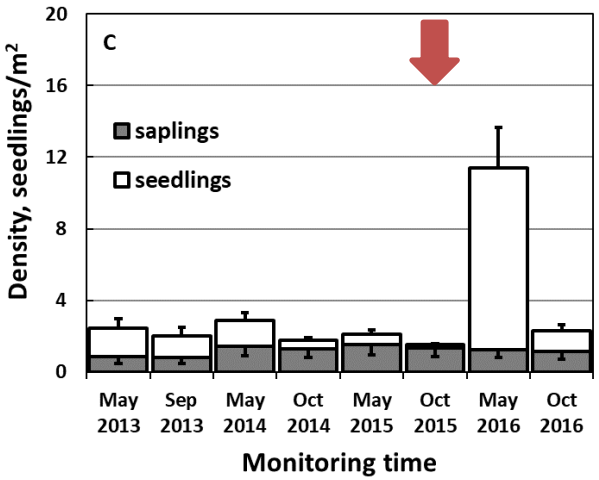


For each yearly cone production, seeds were classified as germinable (G), apparently viable but not germinated (NG), dead (D) and empty (E) after: a) seed separation by a Seed Cleaner device with airflow, b) germination experiments at 20°C in continuous darkness, after 4 w cold stratification at 2-4 °C and c) cut tests applied to seeds that did not germinate. Infertile and insect infested seeds were discarded prior to classification.

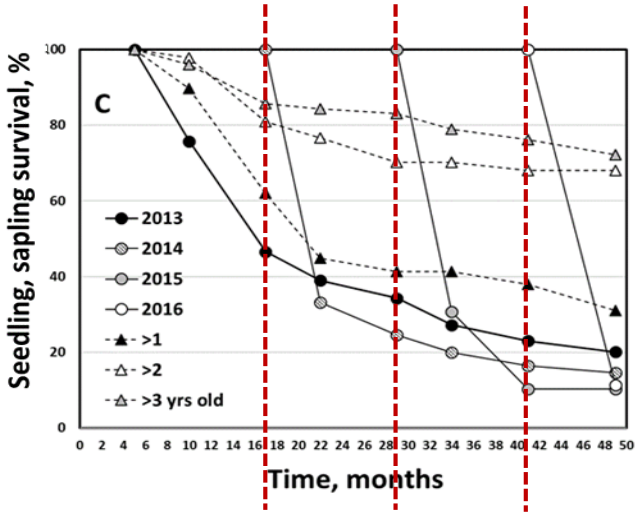
951B *Abies cephalonica* forests

951B *Abies cephalonica* forests

seedling - sapling density - survival

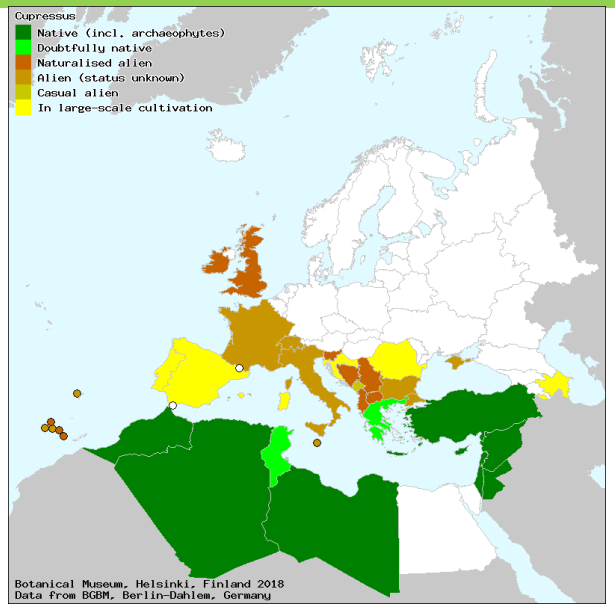


almost stable in autumn
(approximately 2 saplings per m^2)



annual seedlings cohorts and saplings
(older than 1, 2 and 3 yrs old at time 0)

9290: Cupressus forests (*Acero-Cupression*)



92. Mediterranean deciduous forests

native in Greece (Kriti, East Aegean Is.); Cyprus

both serotinous and non serotinous cones

IUCN
globally and Mediterranean 'Least Concern' (LC)

Euro+Med PlantBase; Lev-Yadun (1995); Farjon (2017); Swarup et al (2021)

to conclude…

- ✓ conservation of the genetic diversity in Mediterranean forests has become urgent in light of the climate change challenges and the need to maintain resilient forest ecosystems,
- ✓ seed germination data, concerning temperature, light and/or stratification requirements, contribute to both the understanding of the ecophysiology of germination and the proper 'management' (*in situ* and *ex situ*) of trees and forests,
- ✓ optimal seed storage conditions are essential for any attempt towards the conservation of a plant species and for habitat restoration, as well,
- ✓ the development of appropriate forest reproductive material and the enforcement of protocols will make reproductive material more available for forest landscape restoration and the regeneration of degraded forests,
- ✓ further scientific knowledge is necessary, enhanced by field surveys and laboratory studies, which is expected to contribute to the conservation of biodiversity on the fragile and endangered, by a number of threats, Mediterranean mountainous forests.

research necessary

- ✓ future fire regimes increase risks to obligate-seeder forests (McColl-Gausden et al. 2021)
- ✓ changes in the seasonal timing of fire can have significant effects on plant reproduction, survival and recruitment in fire-prone ecosystem (Tangney et al. 2023)
- ✓ high altitude species and forests not adapted to fire

Abies cephalonica