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CAUSAL ANALYSIS OF THE RANGE OF *STYRAX OFFICINALIS* IN ITALY

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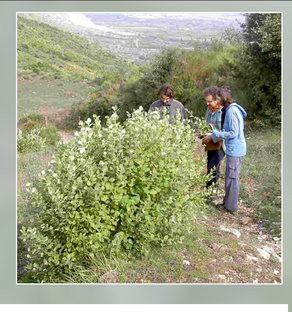


INTRODUCTION

Styrax officinalis L, a small, deciduous tree of *Styracaceae*, is one of the crucial species of Mediterranean phytogeography, a relic of a late-Neogene's floral stock. It ranges from Palestine to S and W Turkey, the Aegean region, the SW Balkan Peninsula and reaches central Italy in a very restricted enclave at around 42 degrees latitude (Fig.1). Populations are concentrated on the hills East of the city of Rome. This westernmost Italian outpost of the Aegaeo-Anatolian-Palestinian range-bulk of the species occupies an area where the floral associates in the community exhibit a strong thermophilic character (*Hyparrhenia hirta, Ampelodesmos mauritanicus, Stipa capensis*) and a conspicuous amount of small thermophilic deciduous trees (*Carpinus orientalis, Cercis siliquastrum, Pistacia terebinthus, Paliurus australis*). It usually grows in forest communities dominated either by evergreen trees or by sub-Mediterranean deciduous trees and treelets, often in contact with primary or secondary dry grasslands (Fig. 2). The species due to its peculiar, discontinuous range in peninsular Italy is by some students consider to be an ancient import from the East (Pignatti, 1982). Other sources stress its relic character (Montelucci, 1984) going back to a late Neogene (Palamarev, 1989) establishment in the area. Here we suggest that the relic character of the stands might be related to some outstanding features of the local environmental envelope, providing favourable conditions for the persistence of the species.

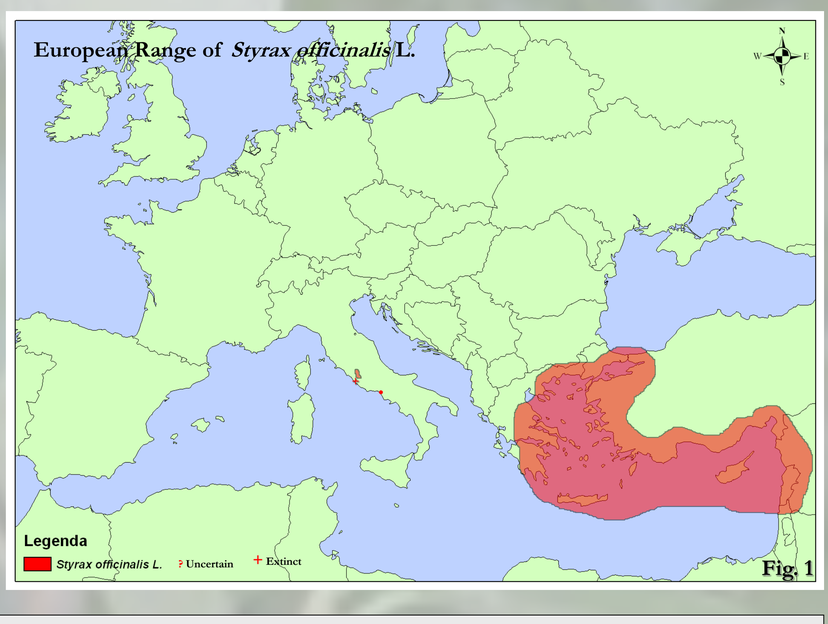


Fig. 1

COENOLOGY OF *STYRAX OFFICINALIS* L. IN CENTRAL ITALY

Fig. 2

A: MEDITERRANEAN BROADLEAVED SCLEROPHYLLOUS FOREST

QUERCETEA ILICIS Br.-Bl. 1947
Quercetalia ilicis (Br.-Bl.- ex Molinier 1934) Riv.-Mart. 1975
Quercion ilicis (Br.-Bl.- ex Molinier 1934) Riv.-Mart. 1975
Viburno tini - Quercetum ilicis (Br.-Bl. 1936) Riv.-Mart. 1975 - Facies with Styrax officinalis
Viburno tini - Quercetum ilicis (Br.-Bl. 1936) Riv.-Mart. 1975
subass quercetosum suberis (Br.-Bl. 1936) Riv.-Mart. 1975 - Facies with Styrax officinalis

B: SUB-MEDITERRANEAN BROADLEAVED DECIDUOS FOREST

QUERCO ROBORIS-FAGETEA SYLVATICAE Br.-Bl. et Vlieger ex Vlieger 1937
Quercetalia pubescenti-petraeae Klika 1933 corr. Moravec ex Beg. Et Theur. 1984
Teucrio siculi-Quercion cerridis (Ubaldi 1988) Scoppola et Filesi 1993
Mespilo germanicae – Quercetum frainetto Biondi, Gigante, Pignattelli, Venanzoni 2001 - *Facies with Styrax officinalis*
Malo florentinae-Quercetum frainetto Biondi, Gigante, Pignattelli, Venanzoni 2001 - *Facies with Styrax officinalis*
Carpino orientali - Quercetum cerris Blasi 1984 - *Facies with Styrax officinalis*
Rubio peregrinae- Quercetum cerridis Pignatti 1988 -*Facies with Styrax officinalis*

Ostryo-Carpinion orientalis Horvat (1954) em 1958 (Lauro-Quercenion pubescentis Ubaldi 1955)
Pistacio terebinthi-Quercetum pubescentis rosetosum sempervirentis (Blasi & Di Pietro 1998) Allegrezza et al. 2002
Carpinus orientalis and Pistacia terebinthus community - Facies with Styrax officinalis

Roso sempervirentis-Quercetum pubescentis Biondi 1986
subass. *carpinetosum orientalis* Blasi et Di Pietro 1998 - *Facies with Styrax officinalis*

RHAMNO CATHARTICI-PRUNETEA SPINOSAE Riv.-God. & Borja ex Tuexen 1962
Prunetalia spinosae Tx. 1952
Cytision sessiliflolii Biondi 1988
Cercido siliquastri -Rhoetum coriariae Biondi, Allegrezza, Guitian 1988 - *Facies with Styrax officinalis*
Pruno-Rubion ulmifolii O. de Bolòs 1954 *(Pruno-Rubenion ulmifolii* Arnaiz ex Loidi 1983*) - Pistacia terebinthus Styrax officinalis community*

Fig. 3

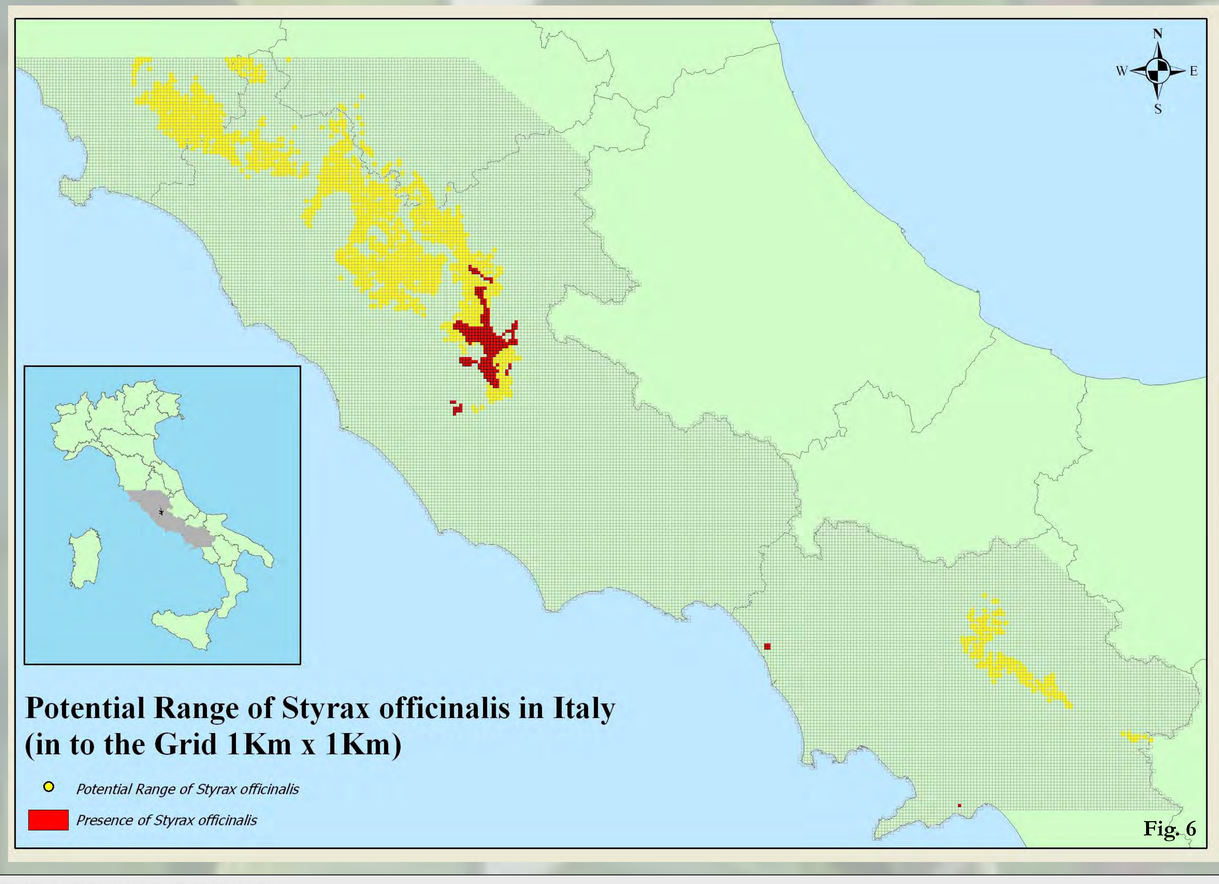
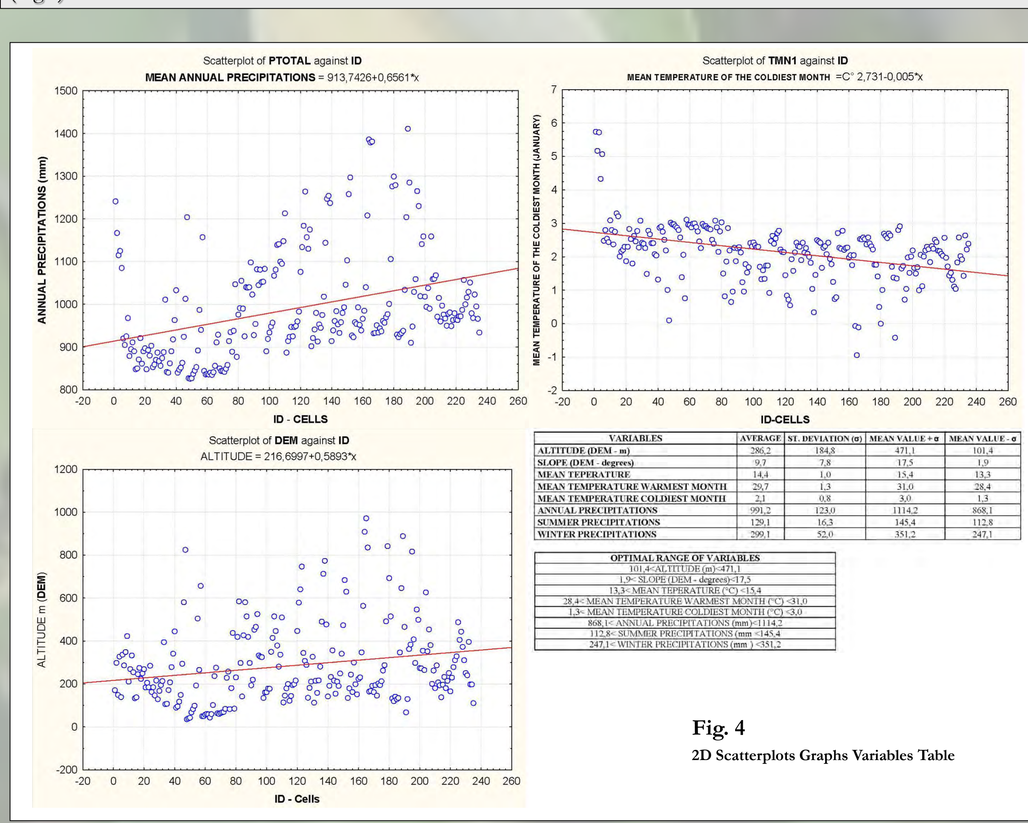


Fig. 6

DISCUSSION

To test the hypothesis of the relic character of these stands we examine the total range of this Italian outpost using descriptive statistics applied to a matrix of environmental data given at the cell centres of a 1 square km grid only to the 235 cells where the species is recorded in the area. On this basis the optimal environmental envelope is parameterized (Fig. 3).
We verify the area where similar environmental conditions are satisfied, within a 31.8871 square km cells geographic grid, encompassing the territory within which the present day stands, the, uncertain stands and extinct populations are recorded.
This territory identifies a biogeographical district corresponding to the Middle Italian region at the west side of the Apennine watershed between 42°44' and 40° 38' N
Environmental variables were selected considering those with a significant influence on the control of the distinct local forest and grassland species.
The climatic data are extracted from the national database of "Progetto Biorefugia" (http://sweb01.dbv.uniroma1.it/bruno/biorefugia/Bioclimatic_Models.html). Topographic data are derived from a Digital Terrain Model (DTM).
In order to model the distribution of the species we use here: mean annual temperature (TM), minimum temperature of the coldest month (TMN1), maximum temperature of the warmest month (TMX7), summer precipitation (PSUM), winter precipitation (P WINTER), total annual precipitation (P TOTAL), slope (SLOPE), elevation (DEM).
The analysis of scatterplots, visualize a relation between the variables (Y axes) and the cells (X axes). It defines the ecological limits, according to the values of the variables used, of the species inside the investigated area (Fig. 4).
The PCA scattergram shows the reciprocal interactions and explanatory power of each parameter. Inspection of the Biplot shows that the populations within the present day range seems to prefer sites at the lowest elevations, where relatively high summer temperatures (about 31° C July mean T) are combined with mitigated winter temperatures (about 4° C January mean T) (Fig. 5).
The parameterization indicating the optimal range for growing has been obtained by calculating the average values for each environmental parameter, adding (for maximum-) and subtracting (for minimum-) the values of the Standard Deviation.
We verify the area where the optimal conditions expressed by each parameter are simultaneously satisfied, within a 31.887 1square km cells geographic grid, encompassing the territory within which the present day stands, the, uncertain stands and extinct populations are recorded.
This simulated "potential range" produced by the parameterization, is the core of the probabilistic approach of this study (Fig.6).



VARIABLES	AVERAGE	ST. DEVIATION (σ)	MEAN VALUE +σ	MEAN VALUE - σ
ALTITUDE (DEM - m)	286,2	184,8	471,1	101,4
SLOPE (DEM - degrees)	9,7	7,8	17,5	1,9
MEAN TEPERATURE	14,4	1,0	15,4	13,3
MEAN TEMPERATURE WARMEST MONTH	29,7	1,3	31,0	28,4
MEAN TEMPERATURE COLDIEST MONTH	2,1	0,8	3,0	1,3
ANNUAL PRECIPITATIONS	991,2	123,0	1114,2	868,1
SUMMER PRECIPITATIONS	129,1	16,3	145,4	112,8
WINTER PRECIPITATIONS	299,1	52,0	351,2	247,1

OPTIMAL RANGE OF VARIABLES
101,4<ALTITUDE (m)<471,1
1,9< SLOPE (DEM - degrees)<17,5
13,3< MEAN TEPERATURE (°C) <15,4
28,4< MEAN TEMPERATURE WARMEST MONTH (°C) <31,0
1,3< MEAN TEMPERATURE COLDIEST MONTH (°C) <3,0
868,1< ANNUAL PRECIPITATIONS (mm)<1114,2
112,8< SUMMER PRECIPITATIONS (mm <145,4
247,1< WINTER PRECIPITATIONS (mm) <351,2

Fig. 4
2D Scatterplots Graphs Variables Table

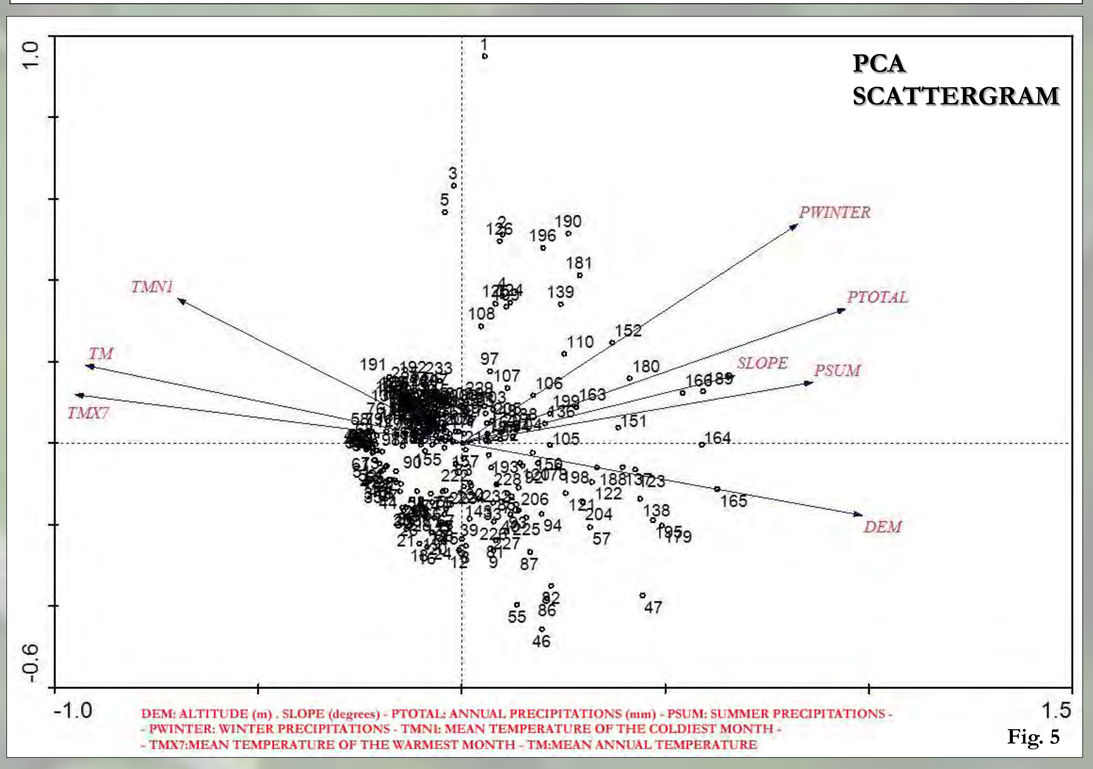


Fig. 5

PRELIMINARY CONCLUSIONS

Within the Italian range of *Styrax officinalis*, its populations are apparently concentrated in sites where winter frost events are virtually absent and where the warmest and driest macroclimatic conditions within the range itself are ruling.
Stands at higher elevations than the local bulk, seem to be positively influenced by orographic precipitation especially in summer. This might suggests the legacy of sub-recent climatic shifts in the area (Late Holocene?).
Considering that the real range is much narrower than the area of the potential range simulated by this experiment, two main hypotheses arise:
- traditional land use leading to deforestation can be suggested as major factor in having reduced the present day range;
- the species might be successful only within a narrow ecological window apparently not limited by the present day macroclimatic constrains here considered, but by local topography and competition by forest trees.

Since local coenology suggests a gravitation of *Styrax* in communities of treelets (*Cercis siliquastrum, Pistacia terebinthus, Carpinus orientalis, Paliurus australis, Acer monspessulanum*) close to primary stands of dry grasslands (*Ampelodesmos mauritanicus, Hyparrhenia hirta*), this mosaic/transitional ecosystem (cfr Zohary 1973; Baruch, 1986) specific only for Latium (Pignatti, 1998) is in fact today nearly completely annihilated by the traditional land use (olive grows).
Nevertheless, not even this simulated range reaches districts of the study area where subcoastal stands are existing, filling the gap between present day inland and coastal stands. Since the latter ones are apparently related to more "relaxated" macroclimatic environmental conditions (highest values of summer precipitation and winter temperature) than inland stands, we suggest that the coastal ones might belong to communities more close to laurophyllic forest relics, while the inland ones, which weight more on the parameterization, are more close to remnants of parklands, open woodlands of xerophilous deciduous trees in contact with extant relics of *Lygeo-Stipetea* communities (extinct stands of *Sarcopoterium*, grasslands with *Ampelodesmos* and *Hyparrhenia*).
Considering the local surprising migrational immobility of the species which apparently cannot rely upon the existing fauna for its spread (Bengtsson K., Spada F. in preparation), a residual and refugial character of the populations and stands is suggested.
This supports the hypothesis of the relic character of the *Styrax officinalis* stands in Italy as a geographical outpost of the egeo-anatolian geoelement.

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