



Features of environments under periglacial conditions in Mediterranean areas

Giuseppe Corti

Dipartimento di Scienze Ambientali e delle Produzioni Vegetali

Università Politecnica delle Marche, Ancona, Italy

Environments under periglacial conditions: the early definitions considered them as the geomorphologic environment at the periphery of the pleistocene glaciers. According to this definition, such environments comprised those territories not covered by ice but that

- 1) were submitted to intense freezing,
- 2) were affected by processes depending on the water freezing and
- 3) hosted the *permafrost*.

permafrost \Rightarrow the soil layer where

$T \leq 0^{\circ}\text{C}$ for 2 consecutive years

However, these conditions not necessarily lie at the margins of a glacier



Peat soils



Sorted stripes

At the English Lake district, UK, there is no glacier but strong are the effects of periglacial conditions on the environment

In case of more intense periglacial processes, even though very far away from a glacier, landscape and soil are transformed more deeply



Sorted stripes at Devon Island Plateau, Devon Island, Nunavut, Canada



Labyrinths at Yellowknife, Nunavut, Canada

Hence, nowadays it is more accepted a definition that does not banish these environments to a geographic area but to the occurrence of some processes. In this way, environments under periglacial conditions are those:

- 1) affected by freezing/thawing cycles so intense to produce drastic modifications of soil surface and soil order, and
- 2) where, usually, the mean annual air temperature is less than $+2^{\circ}\text{C}$ and snow-cover is scarce.

The 25-30% of the land falls under this definition, and in most of these areas there is a type of *permafrost* (continuous, discontinuous, sporadic, isolated)



What is obvious is that most of the environments under periglacial conditions are further the polar circles and, secondarily, on the summit of the greatest continental mountain chains: Andes, Rocky Mountains, Alps, Himalaya.

Little environments under periglacial conditions are in continental areas at relatively elevated latitudes and altitudes such as in France, Belgium, Germany, United Kingdom, Ireland, Iceland, Scandinavian Countries, Russia, Japan, Canada, USA, New Zealand

Of particular interest are the environments under periglacial conditions with limited extensions and that occupy restricted niches such as the top of mountains surrounded by areas with

- 1) a Mediterranean type of climate: Cantabrian Mounts, Pyrenees, Apennines, Balkan Mountains and others in Bulgaria, Turkey, Lebanon, Morocco;
- 2) a tropical/sub-tropical type of climate: Kilimanjaro, K2, Ruvenzori, Ethiopian plateau, and others in Arabia, Chad, Cameroon, Tanzania, Angola, Zambia, Lesotho, New Guinea,



Threatened environments
these areas are small and isolated and do not have a sufficient inertia to overcome another warming phase; because of this, these environments are those most threatened by the forecasted climatic warming.

Most of these areas are poorly known and studied as they are rather extraneous to the environments diffused under the generalized climatic conditions of that place and they are far away from the courses of those who study environments submitted to periglacial conditions.

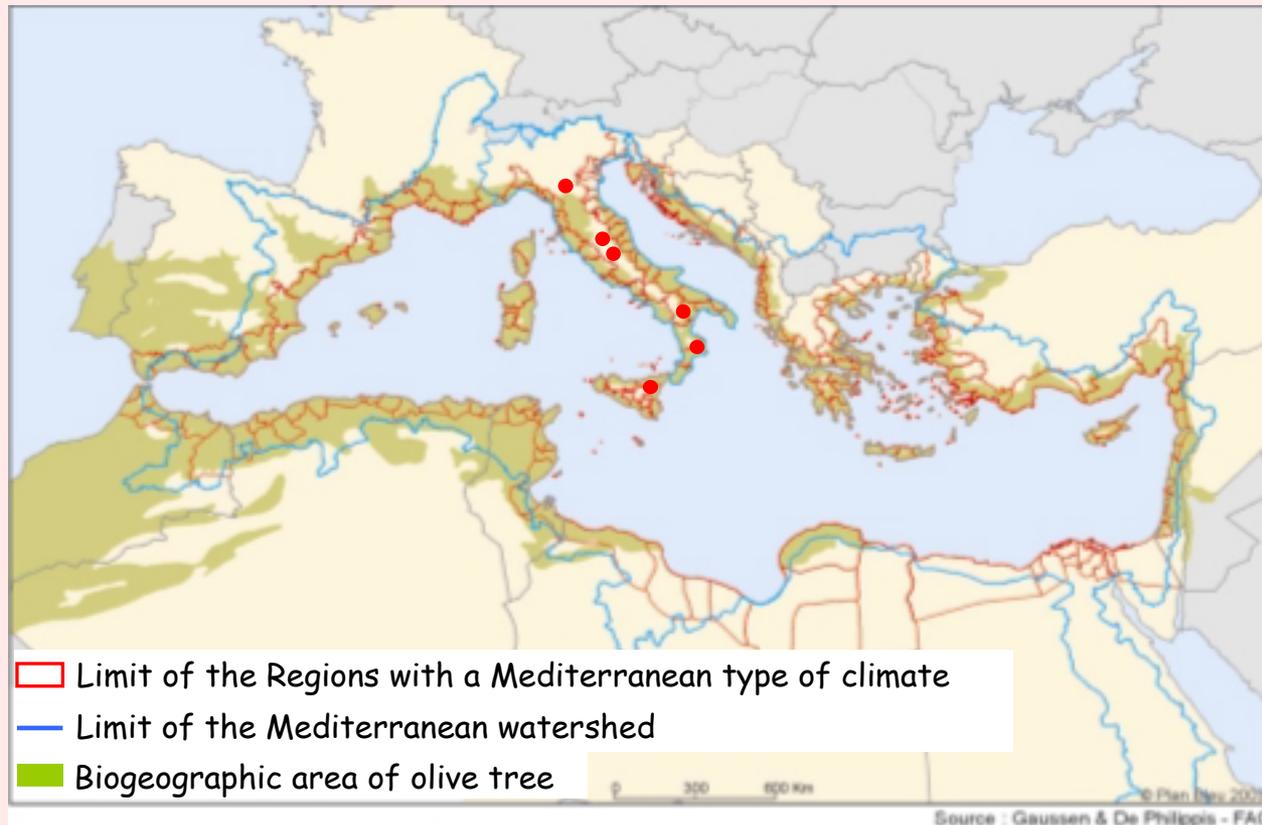
Nonetheless, they have many interesting aspects:

- 1) they experienced one (or more) big climatic change in the last 10,000-13,000 years;
- 2) they are nowadays considered quite instable as they are in the process of changing (they are crossing the swamp....);
- 3) they are surrounded by areas that already changed 2-3 decades ago;
- 4) they may reveal ecological aspects of changing that in the "real" environments under periglacial conditions are still far-off to occur;
- 5) they are a sensitive index of the climatic warming as their inertia to climatic changes is very small.

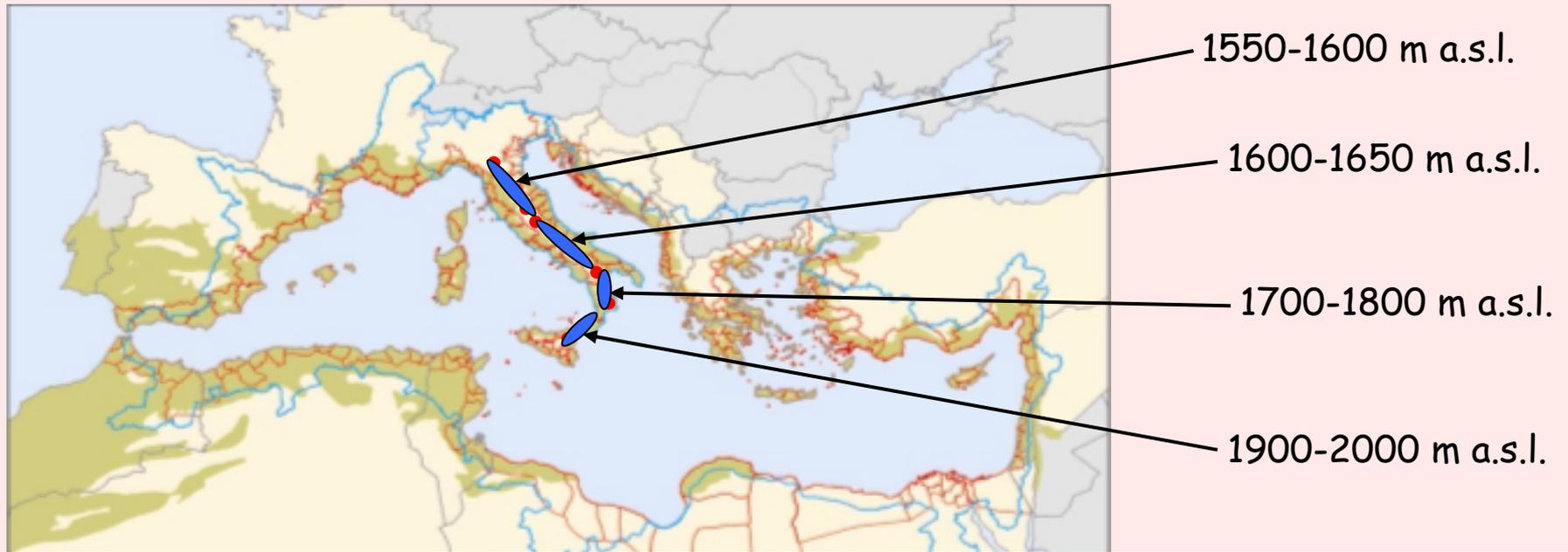
They are worthy to be studied and not neglected

Amongst the areas worthy to be studied, the Apennines chain is one of the more suitable as they

- 1) are surrounded by seas (Tyrrhenian and Adriatic),
- 2) represent an elongated climatic island surrounded by Mediterranean climatic conditions and
- 3) have several areas submitted to periglacial conditions.



During the last glaciation (Würm, from 110,000 to 9,000 YBP), the altitudinal limit of the glaciers in the Apennines increased from 1550 m in the central-northern portion to 2000 m in the southern portion.



With the climate change consequent to the end of glaciation, most of the glaciers disappeared and the previous glaciated areas acquired periglacial conditions. At lower altitudes, periglacial conditions changed to temperate conditions.

This means that:

- 1) in the land where there was a glacier now there are features of the past glaciation together with features acquired under present periglacial conditions, while
- 2) in the land where there were periglacial conditions the features acquired are now relict or have disappeared.



Actual patterned ground

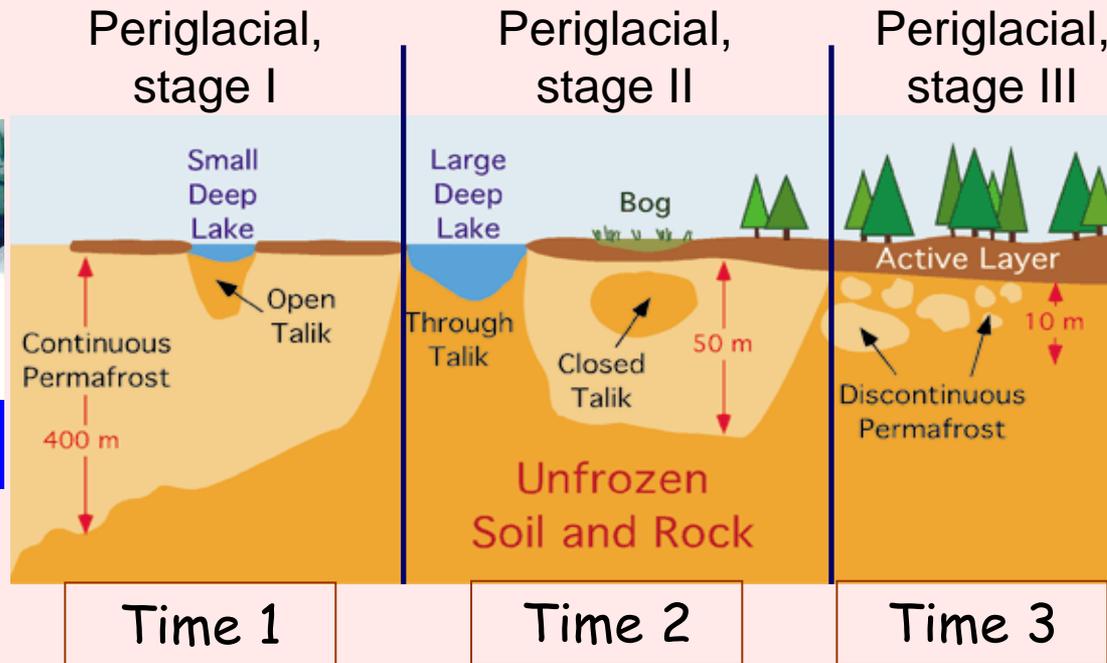


Relict (vegetated) patterned ground

WARMER CLIMATE



glacier



On isolated mountains, it appears that

- 1) not necessarily there is land continuity and only one stage can be present as it is part of a chrono-sequence
- 2) in time, some morphologies previously originated may evolve toward other forms or remain as relict

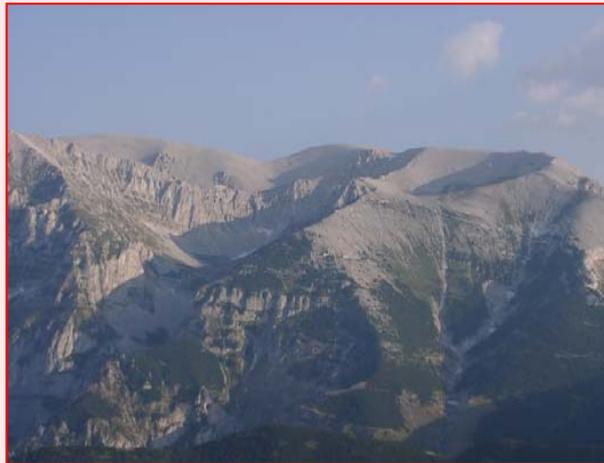
In northern and central Apennines, areas submitted to periglacial conditions are still sufficiently extended to allow evolution of geo- and pedo-morphologic forms typical of such environments. Unfortunately,

- 1) in northern Apennines mountains almost never exceed 2000 m of altitude, while
- 2) in central Apennines mountains often exceed 2000 m of altitude.

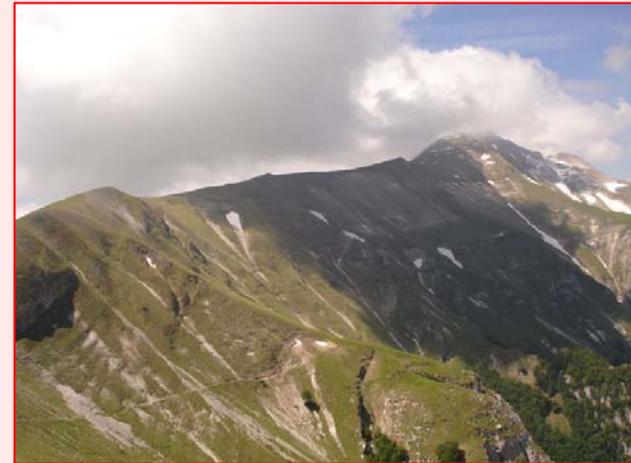
This means that the environments with stronger periglacial conditions are more south



Campo Imperatore Valley,
Gran Sasso massif



Monte Amaro, Majella massif



Cresta del Redentore,
Sibillini massif

Because of geomorphologic reasons, the massifs in central Apennines represent a sequence of periglacial conditions rarely present in a so restricted area

+ Intensity of glaciation **-**

Gran Sasso massif

Majella massif

Sibillini massif

+ Actual periglacial conditions **-**

- Vulnerability of the periglacial ecosystems **+**

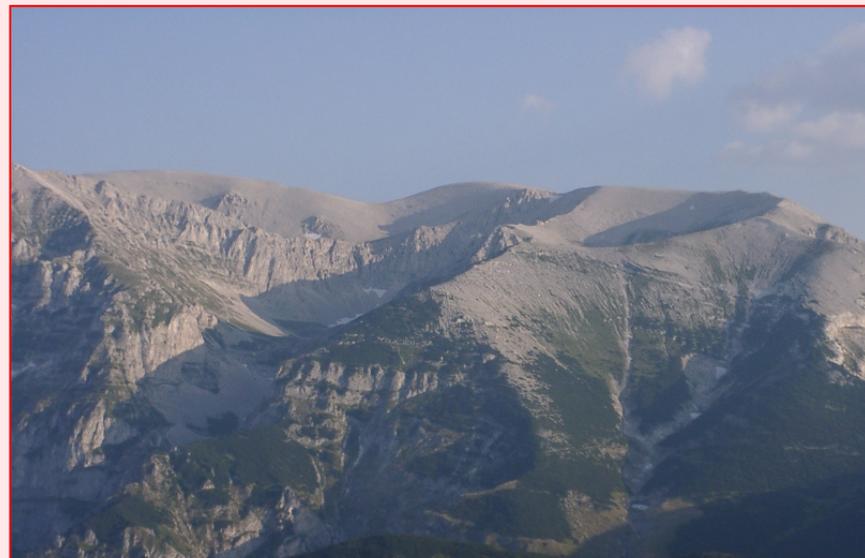
On the Majella massif now there are periglacial conditions of stage II, with morphologies of the past glacial period partially modified by the action of the present periglacial conditions:

Glacial amphitheater

Glacial circus

U-valleys

Roches montonnées



Glacial amphitheater and circus



U-valley



Roche montonnée

There are also features developed during the receding of the glacier:

Kettle holes

Rock glaciers (with interstitial ice)



Bottom valley with kettle holes



Rock glacier

On the vast plateaus over 2000 m a.s.l., there are features typical for environments submitted to intense periglacial conditions

Stones' fields

Flagstones with biological zonation

Peat soils and micro-Histosols

Patterned ground

sorted circles

sorted stripes



Stones' field due to frost shattering



Flagstone with biological zonation



Peat soils

Patterned ground at sorted circles



Patterned ground at sorted stripes



circles - plugs



Profile in a stony soil



Silt-sand cap



pendents

These environments may also reveal unexpected ecological aspects:



Arctic vole

Chionomys nivalis Martins

This mouse lives only on the Majella massif, even though the Gran Sasso massif is higher.

As it is not lethargic, in winter needs to eat more than in summer; but in winter the soil is snow-covered and it makes galleries in the snow-pack where it stokes grasses and seeds.

It needs soils able to produce much biomass, and this need is ensured on the Majella massif by the presence of soil enriched of wind-blown volcanic materials.

Its activity is important as, at the thawing, the remainders of the galleries, rich of feces and urines, rest on the ground; this material acts as a mulching and is able to anticipate the sprouting of some seeds of 7-10 days, a huge amount of time in a place where the growing season is of about three months





Other features of such environments are those, but this is another story.....

Thanks for your attention

