Effetti sulla biodiversità di artropodi e nematodi

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External help: Giorgio Catani and Sauro Visconti

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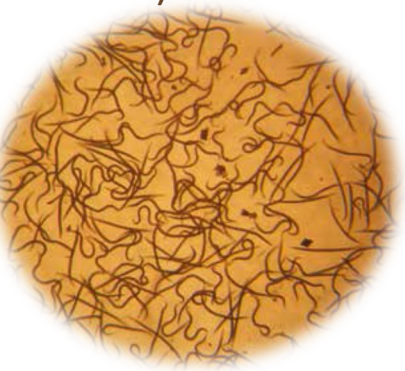
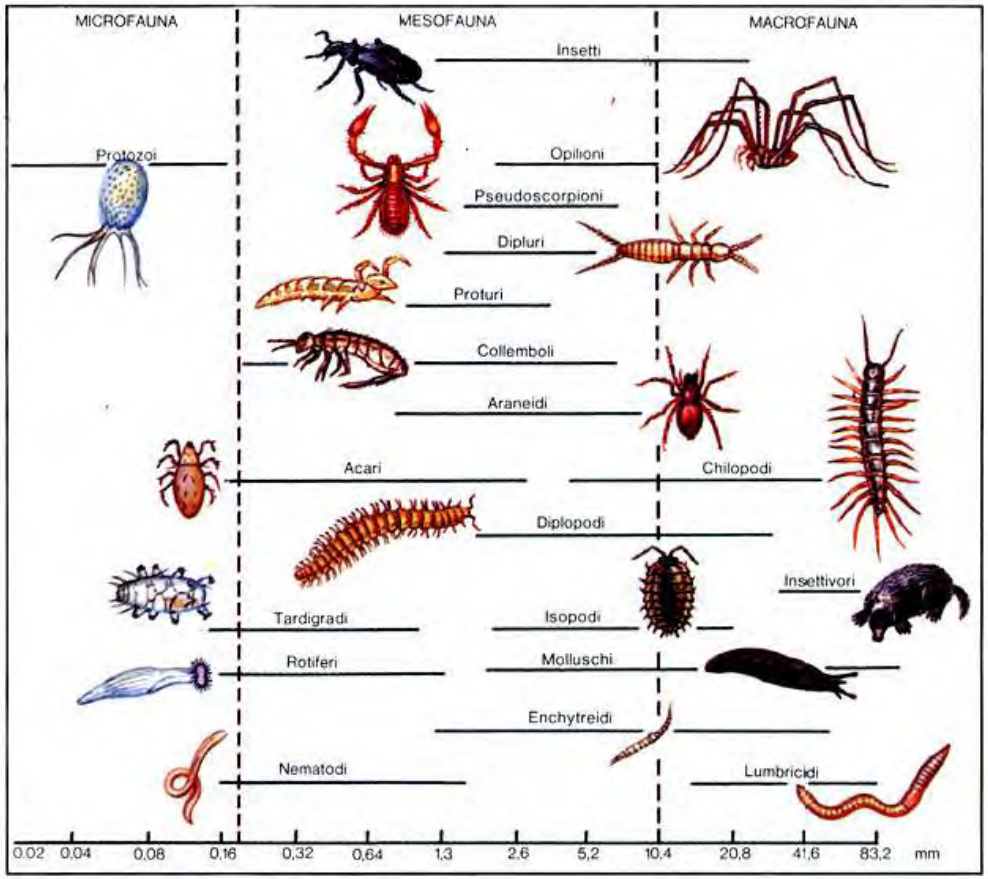
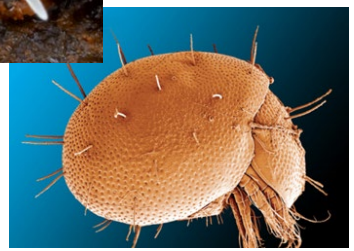
Soil animal biodiversity

Over 1000 species of invertebrates can be found in 1 m^2 of European beech forest (Schaefer and Schauermann, 1990).



Nematodes - belonging to Micro and Mesofauna





Microarthropods - belonging to Mesofauna

Carabids - belonging to Macrofauna

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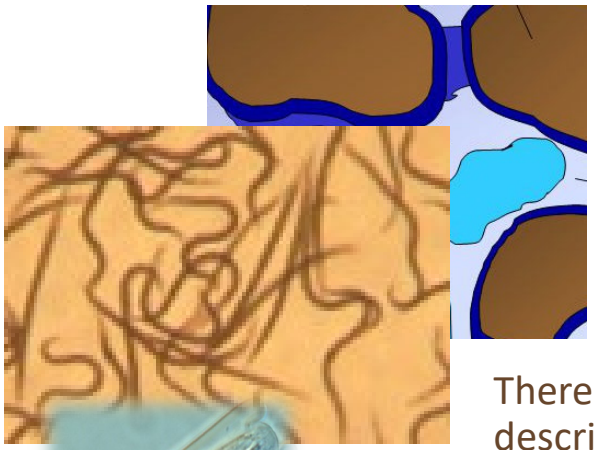
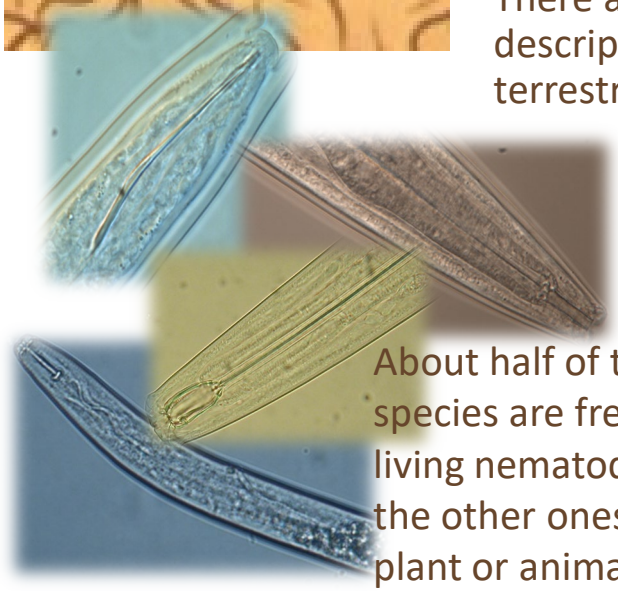
Nematodes – the most important secondary consumers within the soil fauna



Nematodes live in every cm^3 of soil or sediment and occupy the interstitial spaces.

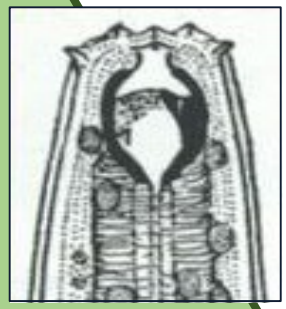
There are 19000 species descripted in water and terrestrial ecosystems



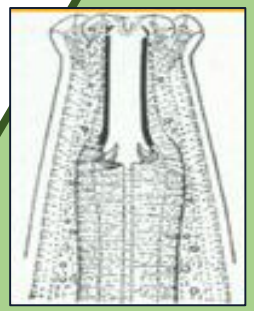
About half of these species are free-living nematodes, the other ones are plant or animal parasites.

Represent trophically heterogeneous groups, thus they are a central element of the soil food web.

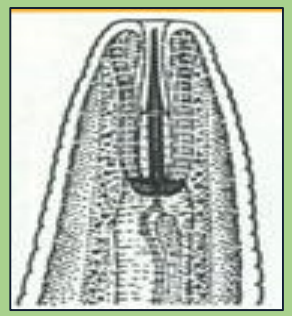
Omnivores



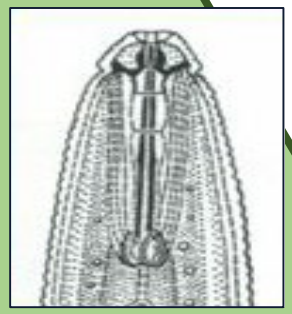
Predators



Bacterial feeders



Fungal feeders



Plant parasitic nematodes

The cycling of nutrients in the soil is controlled by nematodes, mainly by stimulating microbial growth when feeding on them.

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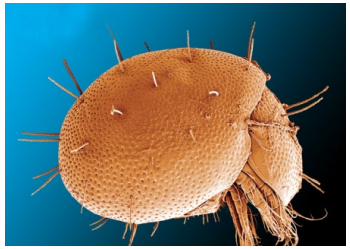
Microarthropods – destroyers of organic matter

Microarthropod roles in food web :

-Shredding of plant residues
-Destruction of organic matter and its translocation
-Microflora and micro fauna dispersion
-Micro and mesofauna predation

Springtails – 7.500 species descripted



Mites – 50.000 species descripted

Large springtails and epigean mites

Diptera larvae

Diptera larvae, isopoda.

Small springtails and, oribatids.

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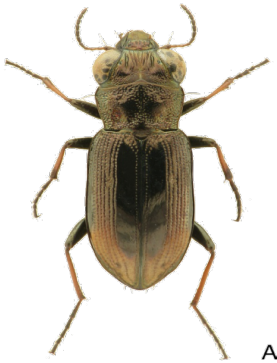
Carabids – the most predators of soil arthropods

4000 species in the world, in Italy 1300

The Carabid Beetles are geophilous epigeal insects whose spatial distribution and whose morphological and ecological characteristics (e.g. wing morphology, diet and body length) are strongly influenced by physical parameters (e.g.: humidity, temperature) and chemicals (pH, concentration of metals) in the soil, this makes these insects indicators of the effects of environmental changes (e.g. soil heating, management and pollution) on soils and humus forms.

Abax

Percus



Notiophilini - *Notiophilus*

Most carabids are polyphagous predators. However, some species are more specialized, such as the *Notiophilus* that feed on Collembola and the *Siagona* that feed on ants

The zoophagous species (e.g. *Poecilus, Sterophus, Brachinus, Anchomenus*) play an important role by predation many species of phytophagous insects.

Carabus

Nebria

Many species have lost the ability to fly

The decline of the Carabidae in the last century in Europe and the role of these Coleoptera as predators of insect pests and as the prey of many Vertebrates makes the knowledge of their spatial distribution in relation to human activities a priority.

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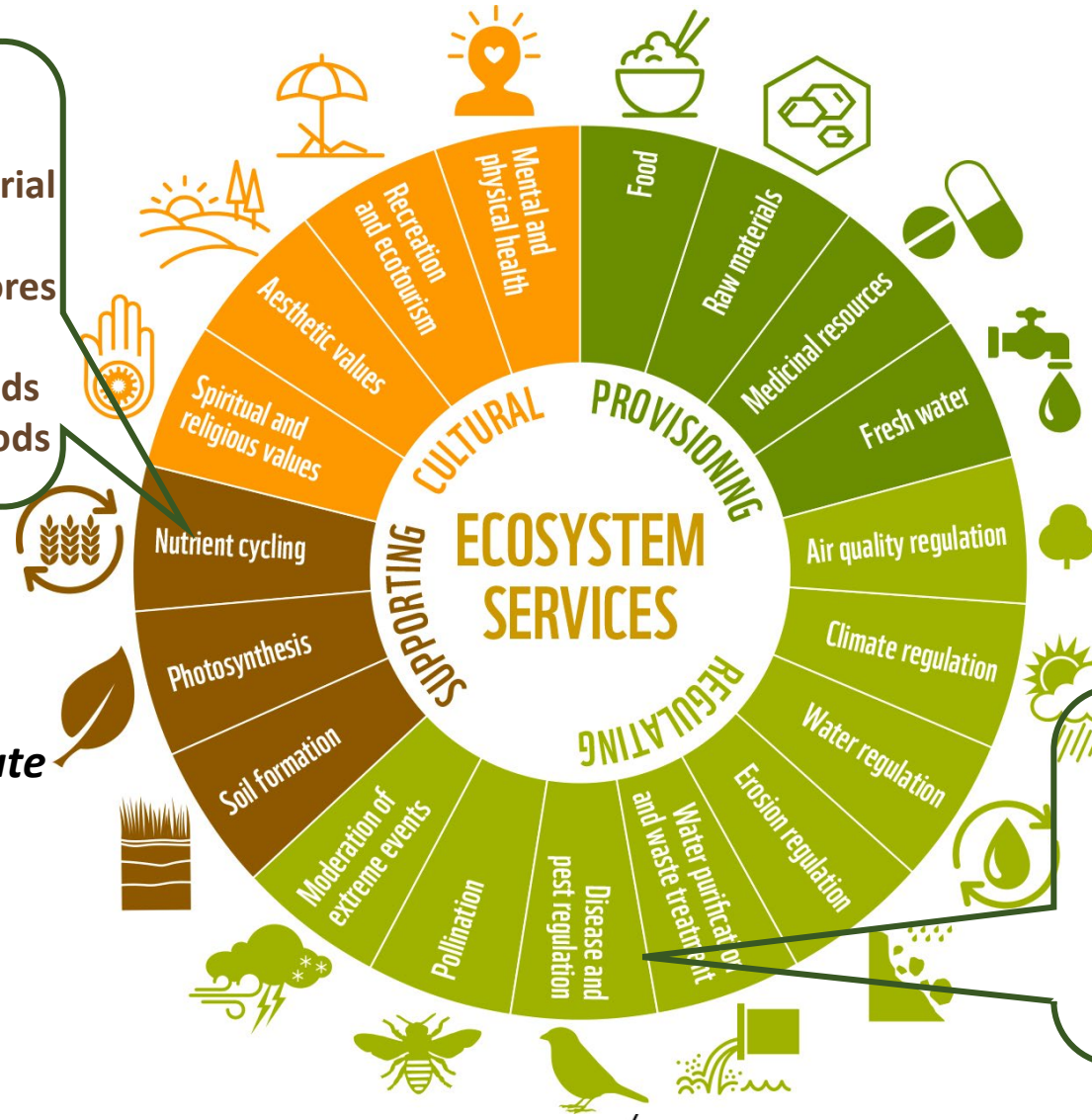
Soil fauna roles in the ecosystem services

- Free living nematodes (including bacterial feeders, fungal feeders, omnivores and predators).
- Microarthropods
- Macroarthropods



"The multiple benefits provided by ecosystems to the human well-being" (Millennium Ecosystem Assessment, 2005).

Forest management must contribute to the animal biodiversity conservation

Predators (including nematodes, some orders of microarthropods and Carabids) / plant parasitic nematodes and insect phytophagous

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Aim – evaluation of two different thinnings on soil animal biodiversity

DB – Thinning from below

DS – Selective thinning

C - Control

In the past…

NEMATODES
In Finland, thinning caused a reduction of nematode population (Huhta, 1967)

ARTHROPODS
In Finland, thinning caused a reduction of springtails and coleoptera abundance (Huhta, 1967)

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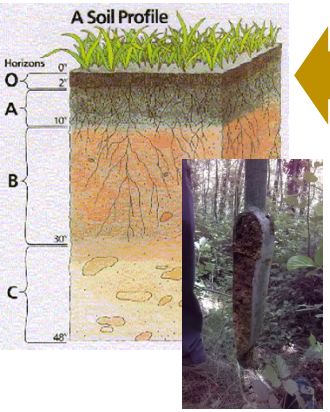
Soil sampling and extraction methods

Soil samples were collected separately from the two areas in May 2015, 2016, 2017 and 2018. For each area 9 plots (1ha) were delimited. For each plot, three samples of soil were collected

Nematodes



Free living nematodes predominate in shallow soil (0-20 cm).

The sample were collected using hand auger to take top 20 cm layer of bulk soil.

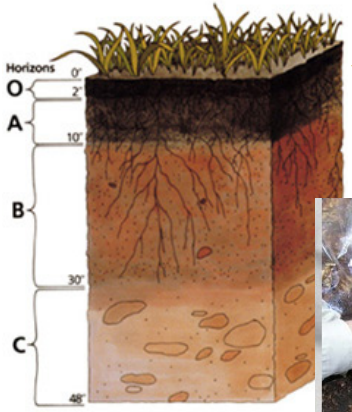
Extraction by cotton-wood filter method: Nematodes were isolated from 100 ml of each soil sample.

Macroarthropods

Carabids live on the soil surface

Carabids caught by pit fall traps after 15-20 days

Microarthropods



Microarthropods live in the deep top layer of soil where the amount of organic matter is high.

Samples - a 10 cm cube

Extraction by Tullgren-Berlese funnel

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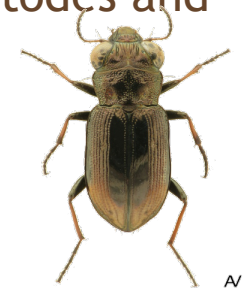
Evaluation indices

BIOINDICATORS
Nematodes and arthropods are used as valid tools to determine the impact of several human activities on soil ecosystem.

1) Nematode and arthropod diversity was assessed by Shannon Weiner index
2) Soil quality indices for nematodes and microarthropods
3) Dominant index for Carabids



Nematodes – Maturity index by Bongers (1990)

Nematodes show a range of reactions to disturbances in soils. In MI, the nematode families are classified in the *cp* scale.

1 — **Degraded soil**
2 — **Disturbed soil**
3-5 — **Good soil quality**

C = colonizer nematodes *r-strategy* (GRUPPI 1-2)
- *Developed gonads*
- *Short breeding cycles*

P = **Persister nematodes** *k*-strategy (GRUPPI 3-5)
- *Reduced gonads*
- *Long breeding cycle*

Morphological characteristics give evidence of adaptation to soil environments:

- *reduction or loss of flying, jumping or running adaptations*
- *thinner cuticle for reduced water-retention capacity*
- *blindness*

Microarthropods – QBS-ar by Parisi (1998)

Soil microarthropods are separated according to the biological form approach with the aim of (1) evaluating the microarthropods' level of adaptation of life in the soil environment (EMI values rang from 1 to 20) and (2) overcoming the well-known difficulties of taxonomic analysis to species level for soil mesofauna.

> 100 — **Good soil quality**

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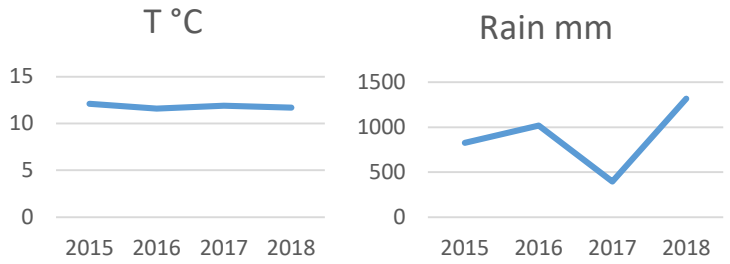
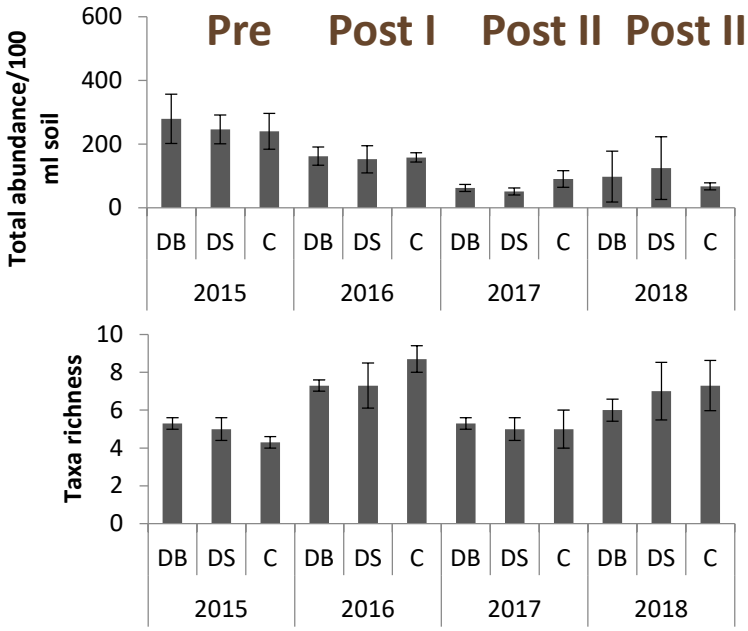
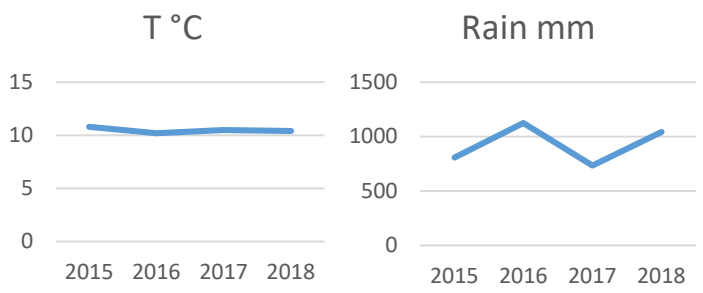
Results – Nematodes

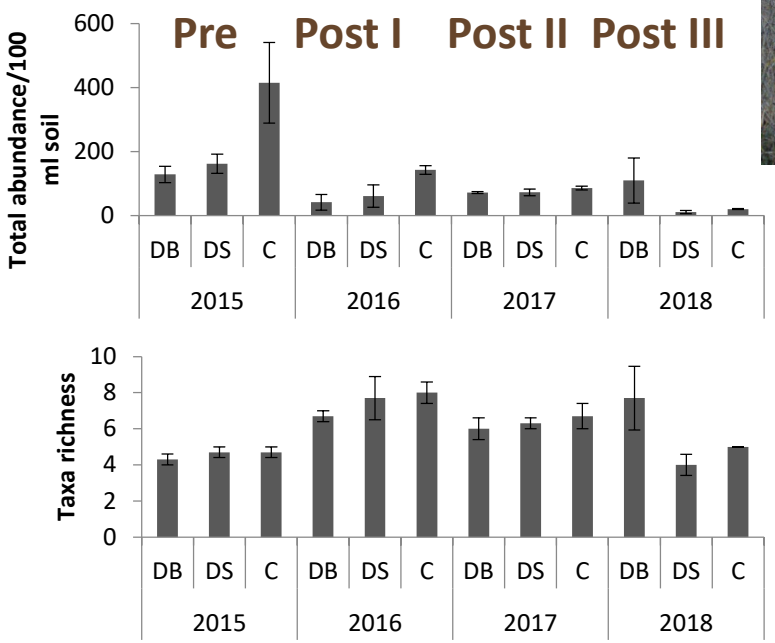
Amiata





Pratomagno





- Differences between years, drought reduced nematode population and richness.
- No significant differences between different treatments.

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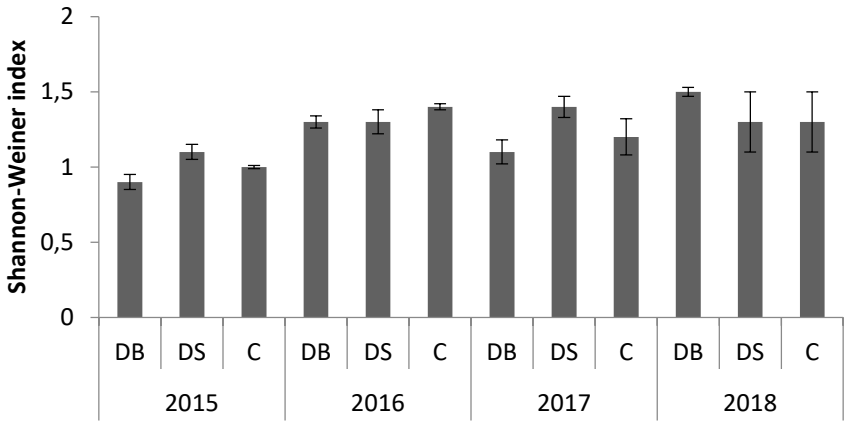
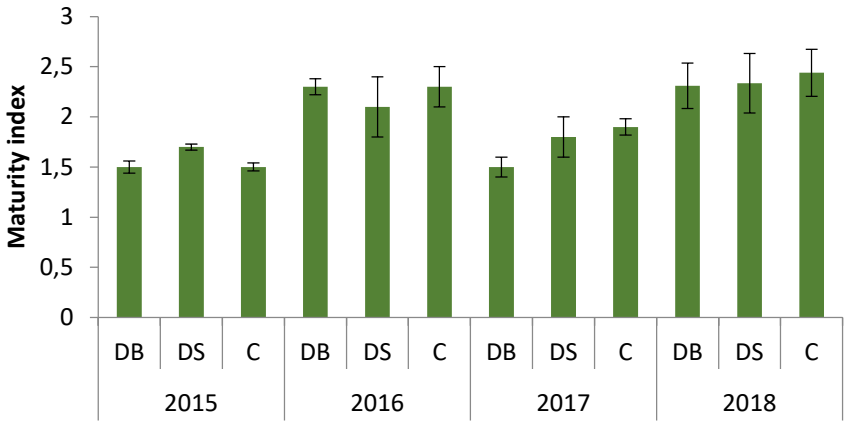
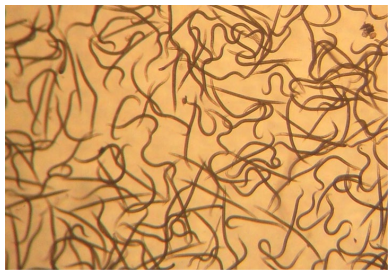
Results - Nematodes

AMIATA







- H and MI values are characteristic of degrades soil.
- The highest H values was found in thinning from below in Pratomagno site.

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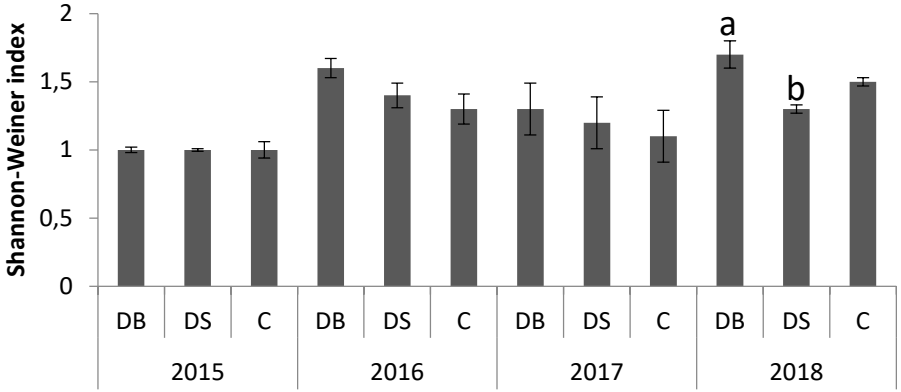

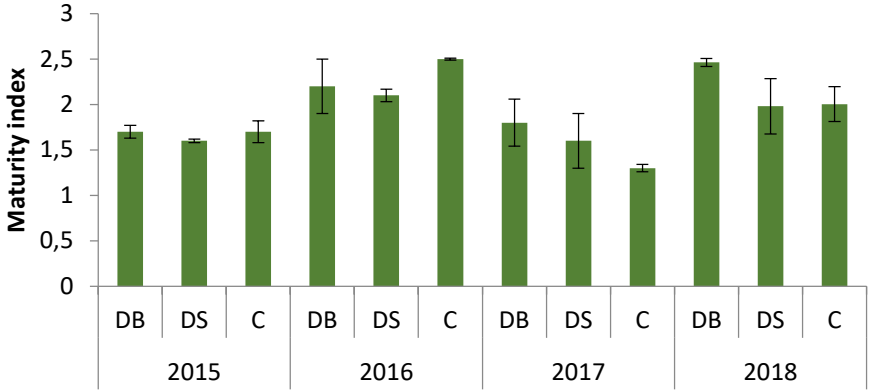

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Results – Nematodes

Amiata

Taxa	Before thinnings			After thinnings		
	DB	DS	C	DB	DS	C
Rhabditidae	+	+	+	+	+	+
Monhysteridae			+			+
Cephalobidae				+	+	+
Aphelenchidae	+	+	+	+	+	+
Discolaimidae			+	+	+	+
Dorylaimidae	+	+	+	+	+	+
Mononchidae	+	+	+	+	+	+
Seinurae			+	+	+	+
Tylenchidae	+	+	+	+	+	+
Paratylenchidae				+	+	+
Anguinidae			+	+	+	+
Hoplolaimidae					+	+
Longidoridae	+	+	+	+	+	+
	6	6	10	11	12	13

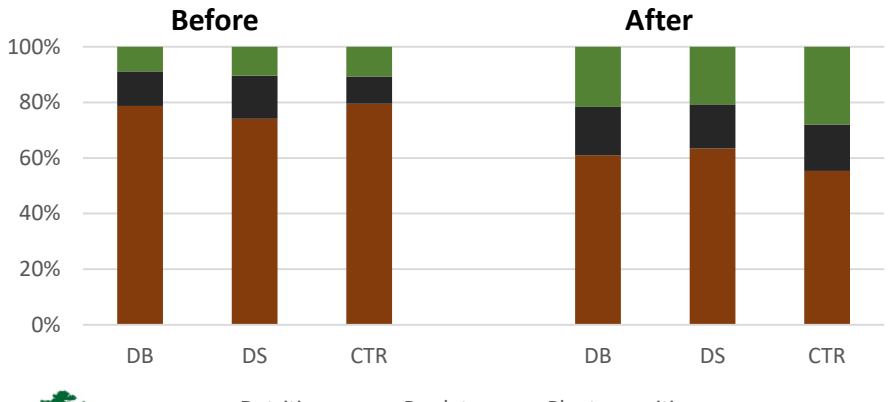
No loss of nematodes taxa

Pratomagno

Taxa	Before thinnings			After thinnings		
	DB	DS	C	DB	DS	C
Rhabditidae	+	+	+	+	+	+
Monhysteridae	+					
Cephalobidae	+			+	+	+
Aphelenchidae	+	+	+	+	+	+
Discolaimidae				+		+
Dorylaimidae	+	+	+	+	+	+
Mononchidae	+	+	+	+	+	+
Seinurae			+		+	+
Tylenchidae	+	+	+	+	+	+
Paratylenchidae			+		+	+
Anguinidae			+	+	+	+
Hoplolaimidae				+	+	+
Pratylenchidae				+		+
Criconematidae				+	+	
Longidoridae	+	+	+	+	+	+
	8	6	9	12	12	13

Predators increased in DB

Amiata



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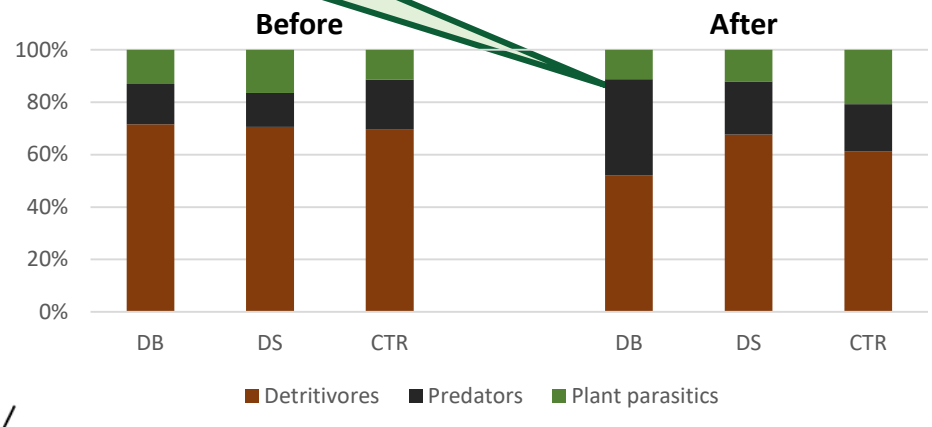

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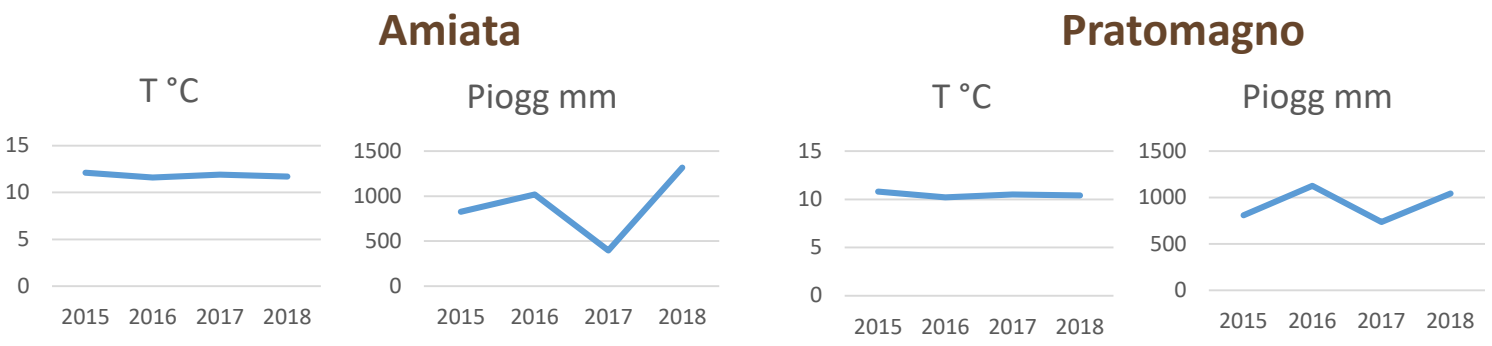
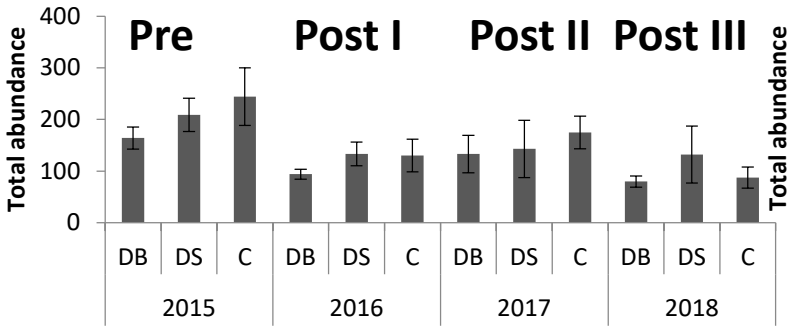
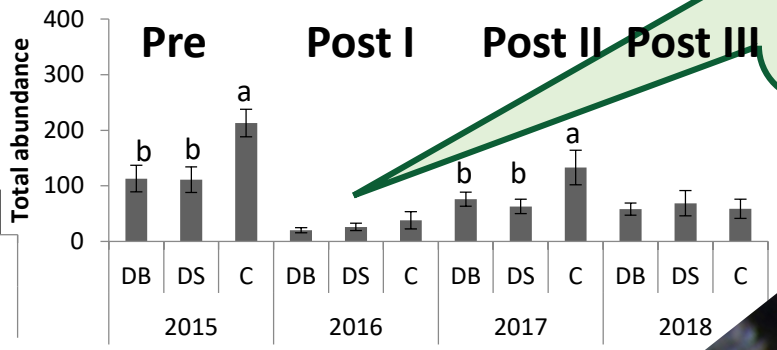
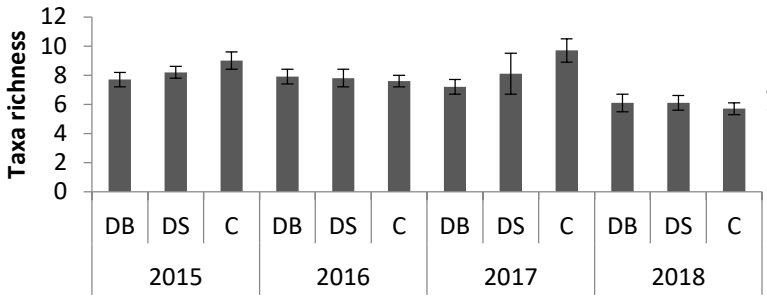
Results - Microarthropods

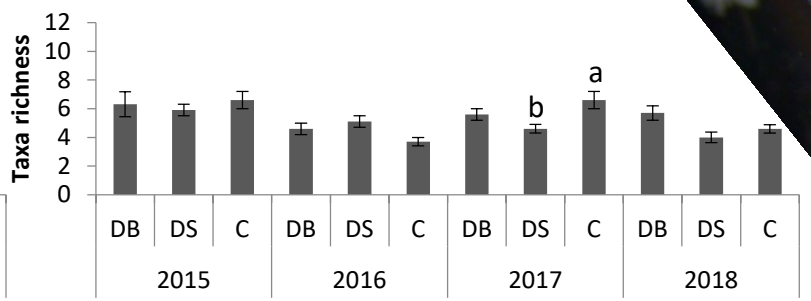


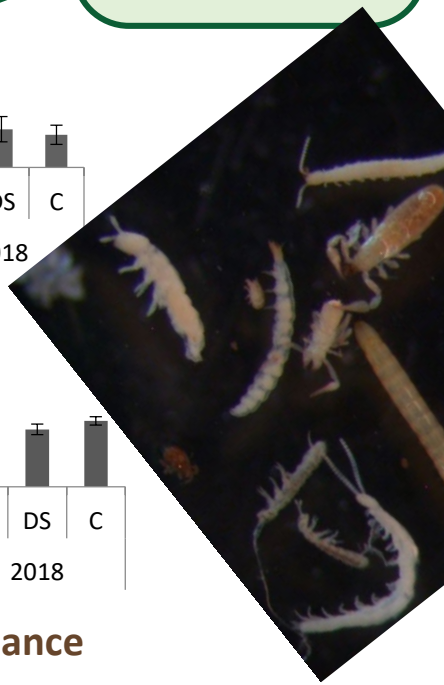
High rainfall has reduced the amount of microarthropods











Selective thinning had negative effects on taxa richness and total abundance during the second years in Pratomagno site.

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Results - Microarthropods

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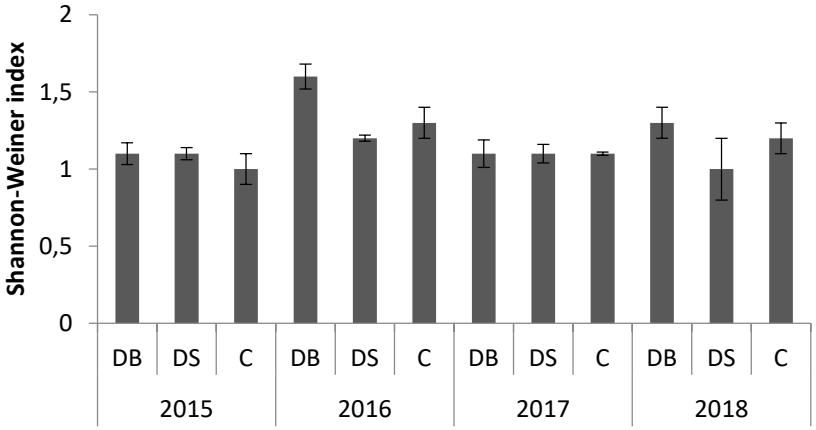
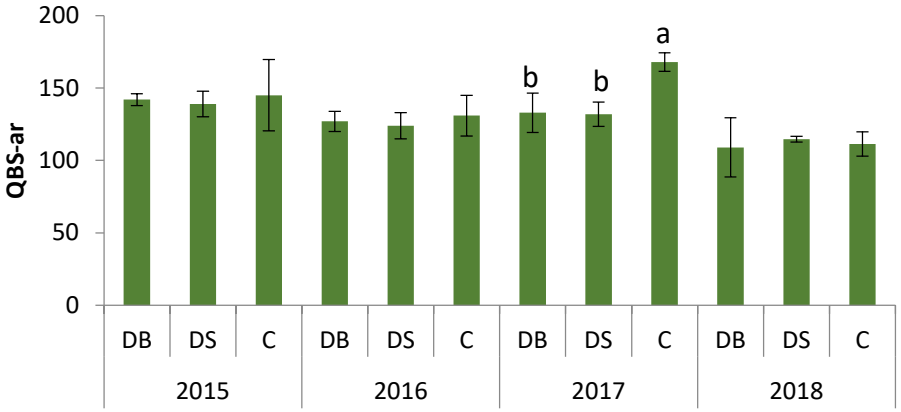
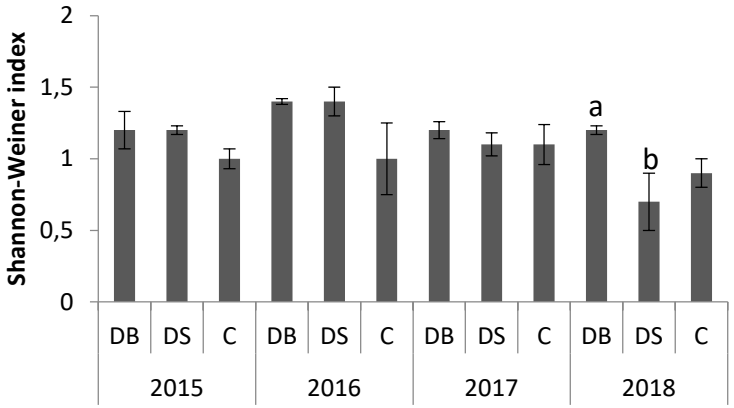
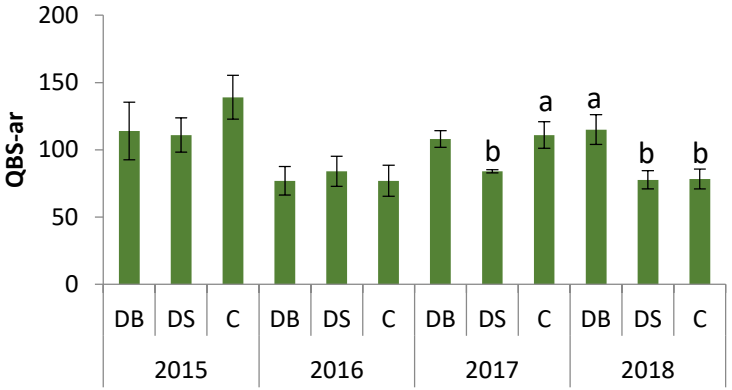




PRATOMAGNO





- QBS-ar evidenced a more degraded environment in Pratomagno than Amiata.
- **The highest indices (H and QBS-ar) were found in thinning from below.**

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NUOVI APPROCCI PER LA GESTIONE SOSTENIBILE DEL PINO NERO:
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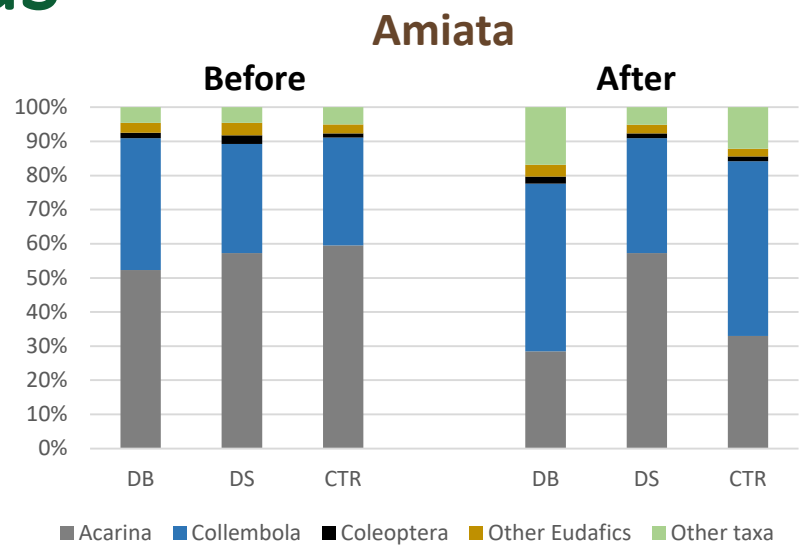
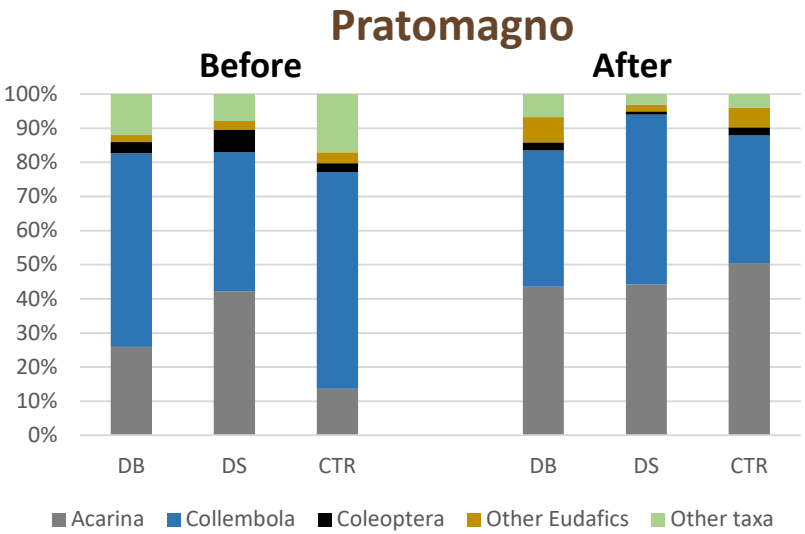
Results - Microarthropods

No loss of microarthropods taxa in both sites.

TAXA	AMIATA						PRATOMAGNO					
	Before			After			Before			After		
	DB	DS	C	DB	DS	C	DB	DS	C	DB	DS	C
Acarina	+	+	+	+	+	+	+	+	+	+	+	+
Araneae	+	+	+	+	+	+	+					+
Opilionida				+		+						
Pseudoscorpiones	+	+	+	+		+			+	+	+	+
Isopoda	+	+	+					+			+	
Chilopoda	+	+	+	+	+	+	+	+	+	+	+	+
Diplopoda	+	+	+	+	+	+	+	+	+	+	+	+
Pauropoda	+	+	+	+	+	+	+	+	+	+	+	+
Symphyla	+	+	+	+	+	+	+	+	+	+	+	+
Diplura	+	+	+	+	+	+			+	+		
Collembola	+	+	+	+	+	+	+	+	+	+	+	+
Zygentoma											+	
Psocoptera	+		+		+	+	+	+			+	+
Hemiptera	+	+	+	+	+	+	+	+	+		+	+
Tysanoptera	+	+	+	+	+	+	+			+	+	+
Coleoptera	+	+	+	+	+	+	+	+	+	+	+	+
Hymenoptera	+	+	+	+	+	+	+	+	+	+	+	+
Diptera	+	+	+	+	+	+	+	+	+	+	+	+
Lepidoptera					+	+						+
Total	16	15	16	15	15	17	13	12	12	12	15	15





AMIATA

The epi and emi-edaphic fauna and acarina increased in DB and DS, respectively.

PRATOMAGNO

The eu-edaphic fauna increased in DB, while coleoptera reduced in DS.

Results - Carabids

N	Specie totali 2015-2018	Ecologia	Area 1 Amiata	Area 2 Pratomagno
1	*Abax parallelepipedus curtulus*	B		x
2	*Calathus (Calathus) fuscipes graecus*	A		x
3	*Calathus montivagus*	B	x	
4	*Callistus lunatus*	A	x	
5	*Carabus (Tomocarabus) convexus*	B	x	x
6	*Carabus (Megodontus) violaceus subsp. picenus*	A (B)		x
7	*Carabus (Archicarabus) rossii*	B	x	
8	*Cychrus italicus*	B		x
9	*Harpalus dimidiatus*	A	x	
10	*Leistus rufomarginatus*	B (A)		x
11	*Microlestes fulvibasis*	A	x	
12	*Molops medius*	B		x
13	*Nebria brevicollis*	B		x
14	*Nebria tibialis doderoi*	B	x	
15	*Nebria tibialis subcontracta*	B		x
16	*Notiophilus biguttatus*	B	x	x
17	*Notiophilus germinyi*	A	x	
18	*Notiophilus rufipes*	B	x	x
19	*Percus passerinii*	B		x
20	*Percus paykulli*	B	x	
21	*Platyderus neapolitanus*	B		x
22	*Pseudophonus rufipes*	A		x
23	*Pterostichus melas italicus*	A	x	
24	*Pterostichus micans*	B	x	x
25	*Trechus obtusus obtusus*	B (A)	x	
26	*Trechus quadristriatus*	A	x	x
Totali x area			15	16
Totale complessivo			26	

Genus *Notiophilus*

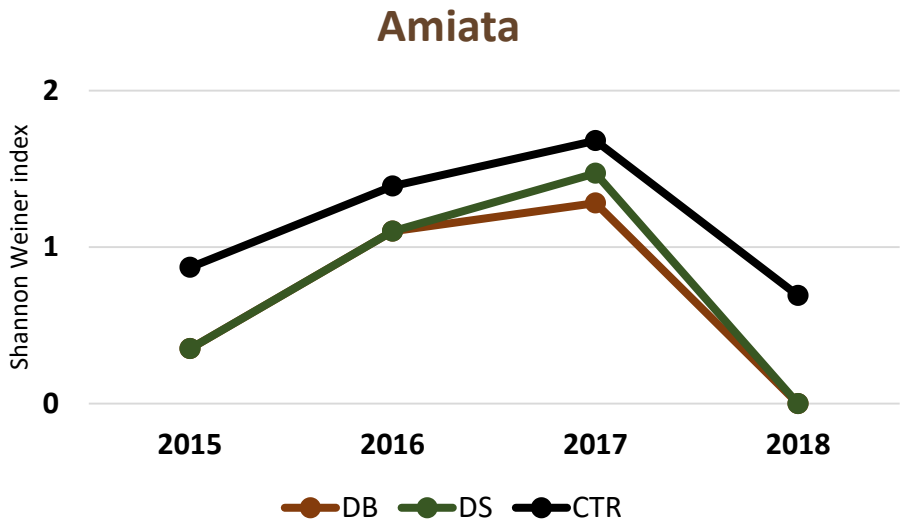
The tribe of Notiophilini with the genus *Notiophilus*, was present in both areas.

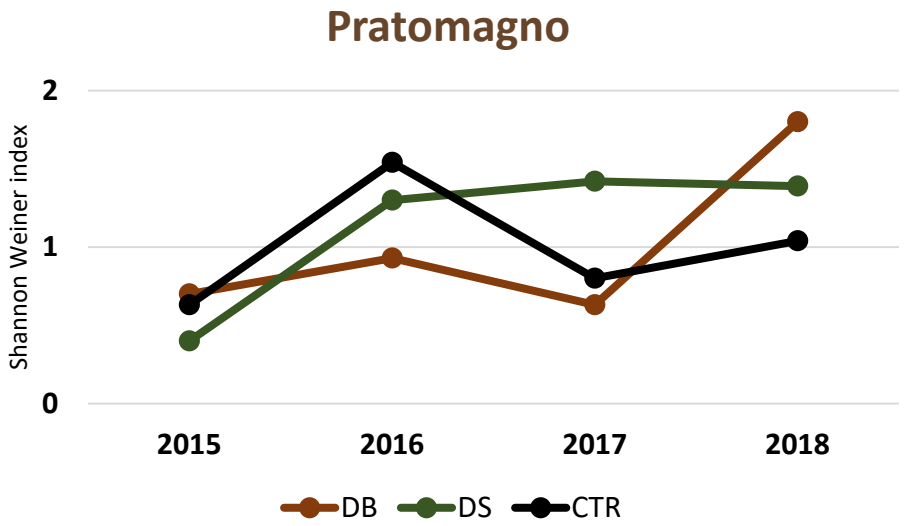
In general…

- **Spatial distribution is related to environment, only five species are common in the two sites.**
- **The steppic species are higher Amiata than Pratomagno.**

Check list: in yellow the forest species and in blue the steppic species. A - steppic species or open environments B - forest species A (B) - species predominantly of steppic environment B (A) - species predominantly of forest environment.

Results - Carabids





AMIATA

- **The highest H values were found in Control.**
- **DB and DS evidenced a low resilience in 2018.**

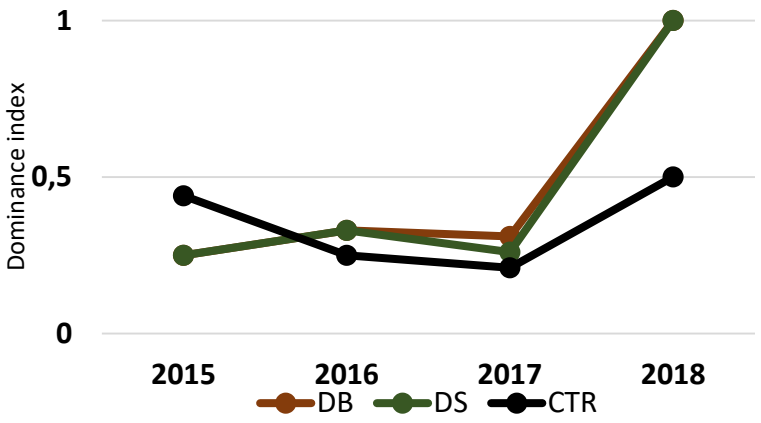
***Carabus (Megodontus) violaceus picenus* Villa & Villa, 1838**

PRATOMAGNO

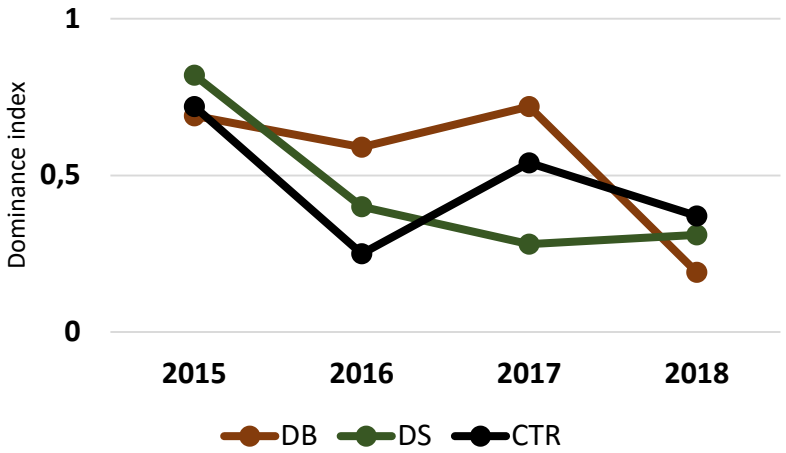
- **The highest H value was found in DB in 2018.**
- **DS showed a crescent trend during years.**

Results - Carabids

Amiata



Pratomagno



AMIATA

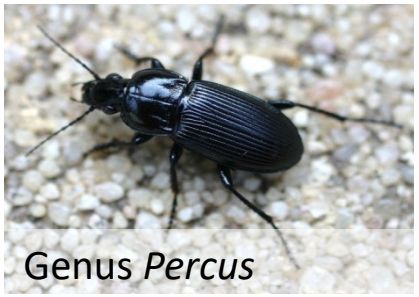
- The D index showed a peak in 2018 when there was only one specie *Percus paykulli*
- During 2016 and 2017 the steppic and forest species increased.

Steppic species:
Callistus lunatus
Harpalus dimidiatus
Notiophilus germinyi
Trechus quadristriatus
Forest species:
Calathus montivagus
Carabus (Tomocarabus) convexus
Carabus (Archicarabus) rossii
Notiophilus rufipes
Percus paykulli

PRATOMAGNO

- Before thinnings *Nebria tibialis subcontracta* was the dominant species


Genus *Nebria*


Genus *Percus*

The Pratomagno individuals, belonging to the tribe Nebriini and Pterostichini, were well represented by genera *Nebria* and *Percus*, respectively.

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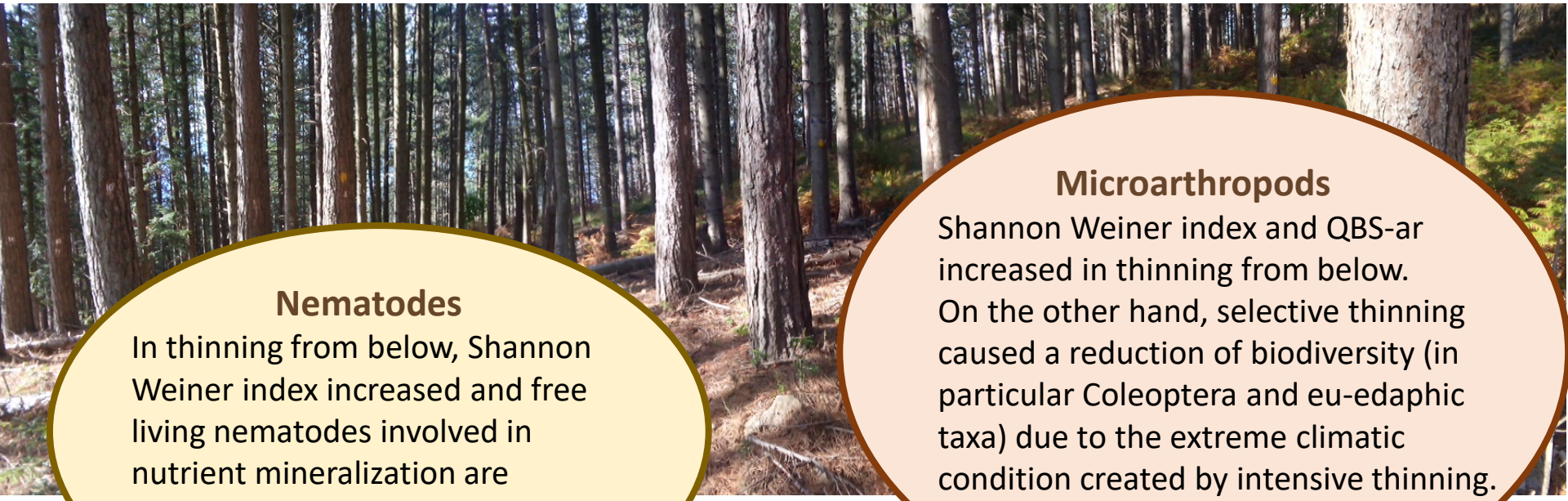
Conclusion



Nematodes

In thinning from below, Shannon Weiner index increased and free living nematodes involved in nutrient mineralization are efficiently regulated by predation.

Microarthropods

Shannon Weiner index and QBS-ar increased in thinning from below. On the other hand, selective thinning caused a reduction of biodiversity (in particular Coleoptera and eu-edaphic taxa) due to the extreme climatic condition created by intensive thinning.

Carabids

Thinning enhance biodiversity (in particular steppic species), but reduced the resilience.

At our latitudes, the forest management by thinning improves biodiversity compared to non-management: the thinning from the below after just three years increased soil fauna, while it takes several years for selective thinning

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